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**CHAPTER 1**  
**INTRODUCTION AND GENERAL DESCRIPTION**  
**OF THE FACILITY**

Information Contained within  
DOES NOT CONTAIN  
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## **1. INTRODUCTION AND GENERAL DESCRIPTION OF THE FACILITY**

### **1.1 INTRODUCTION**

The Code of Federal Regulations, Title 10 CFR 76.35(a) requires that the United States Enrichment Corporation (USEC) submit as part of its application for a certificate of compliance, a Safety Analysis Report (SAR) containing the information specified within that section. This SAR contains the information required by section 76.35(a).

### **1.2 SITE LOCATION AND DESCRIPTION**

The Portsmouth Gaseous Diffusion Plant (PORTS) is located at 39°00'30" N. latitude and 83°00'00" W. longitude measured at the center of the plant, on an approximately 3,708-acre Federally owned reservation in Pike County, Ohio. The site is generally in a rural area, and was previously farmland and the watershed for several intermittent streams. The largest cities within a 50-mile radius are Portsmouth, Ohio, located approximately 27 miles to the south, and Chillicothe, Ohio, located approximately 27 miles to the north. Portions of 24 counties are located within a 50-mile radius of the plant, 18 of which are in Ohio, 5 in Kentucky, and 1 in West Virginia.

PORTS occupies approximately 650 acres within the Controlled Access Area about 1.5 miles east of U. S. Route 23 and 2 miles south of State Route 32, and 2 miles east of the Scioto River.

### **1.3 FACILITIES LEASED BY USEC**

Exhibit A to the Lease [Lease Agreement between the United States Department of Energy (DOE) and USEC, dated July 1, 1993, as amended, hereafter referred to as The Lease] identifies the facilities leased by USEC for PORTS.

### **1.4 PURPOSE OF OPERATION AND OPERATING PARAMETERS**

PORTS enriches uranium using the gaseous diffusion process. A description of this process is provided in Chapter 3 of this SAR.

PORTS is designed to operate at a capacity of 8.6 million separative work units (SWUs) annually at its rated power level of 2260 MW. PORTS may produce uranium enriched up to 10 percent <sup>235</sup>U by weight.

## **1.5 POSSESSION LIMITS**

The possession limits for NRC-regulated source material, by-product material, and SNM are shown in Table 1-3.

## **1.6 AUTHORIZED USES**

The authorized uses for each class of NRC-regulated material are shown in Table 1-4 [see 10 CFR 76.35(a)(2)]. The authorized operations are described in Chapter 3 of this SAR.

## **1.7 SECTION DELETED**

## **1.8 EXEMPTIONS**

The following exemptions to NRC regulations have been identified in this Application:

### Section Exemption

5.3.1.7 Caution signs for Radioactive Material Areas (RMAs), Airborne Radioactivity Areas (ARAs), Radiation Areas (RAs), and High Radiation Areas (HRAs) are maintained as required by 10 CFR 20.1901, 20.1902, 20.1903, 20.1904, and 20.1905 with the following exceptions:

1. Containers located in Restricted Areas within the USEC leased area are exempt from container labeling requirements of 10 CFR 20.1904, as it is deemed impractical to label each and every container. In such areas, one sign stating that every container may contain radioactive material will be posted. By procedure, when containers are to be removed from contaminated or potentially contaminated areas, a survey is performed to ensure that contamination is not spread around plant site.
2. Feed, product, and depleted uranium cylinders, which are routinely transported between facility locations and/or storage areas at the facility, are readily identifiable due to their size and unique construction, and are

not routinely labeled as radioactive material. UF<sub>6</sub> cylinders are constantly attended by qualified Radiological Workers during movement.

<u>Section</u>	<u>Exemption</u>	
6.9, Table 6.9-1	10 CFR 76.120(d)(2) requires that written reports of certain events be submitted to the NRC within 30 days. USEC has been exempted from this requirement provided such reports are submitted within 60 days.	

The following Special Authorizations have been identified in this Application:

1. Surface Contamination Release Levels for Unrestricted Use:

Items may be released for unrestricted use if the surface contamination is less than the levels listed in SAR Table 5.3-2.

**Table 1-1 Table Deleted**

**Table 1-2 Table Deleted**

Table 1-3 Possession Limits for NRC-Regulated Materials and Substances

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
A. Source Material <sup>1,4f</sup>	92	Solid, liquid, and gas	UF <sub>6</sub> , UF <sub>4</sub> , UO <sub>2</sub> F <sub>2</sub> , oxides, metal and other compounds	300,000 MTU <sup>a</sup>	Uranium (including natural, depleted and recycled) and daughter products and process contaminants and wastes
					Laboratory chemicals Analysis of samples <sup>e</sup>
B. Source Material	90	Solid and liquid	Soluble and insoluble chemicals, metal	10 Ci	Instrument calibration and check sources
					Laboratory chemicals, instrument calibration sources, plated metallic sources, instrument check sources Analysis of samples <sup>e</sup>
C. Special Nuclear Material <sup>1b,4f</sup>	92	Solid, liquid, and gas	UF <sub>6</sub> , UF <sub>4</sub> , UO <sub>2</sub> F <sub>2</sub> , oxides, metal and other compounds	300,000 MTU	Uranium (including recycled) enriched in isotope 235 up to 10 percent by weight, uranium daughter products and process contaminants and wastes, to include: (1) laboratory chemicals, (2) analysis of samples <sup>e</sup> , (3) instrument calibration and check sources, or (4) material that may be held up in facilities and equipment from previous operations
					Uranium enriched in isotope 235 from 10 percent up to 20 percent by weight, to include: (1) material that may be held up in uninstalled equipment and facilities from previous operations and in equipment received from other facilities, (2) laboratory chemicals, (3) analysis of samples <sup>e</sup> , or (4) instrument calibration and check sources.

Table 1-3 (Continued)

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
Special Nuclear Material	92	Solid, liquid and gas	UF <sub>6</sub> , UF <sub>4</sub> , UO <sub>2</sub> F <sub>2</sub> , oxides, metal and other compounds	1,000 g <sup>235</sup> U <sup>e</sup>	Uranium enriched in isotope 235 to 20 percent and up to 98 percent by weight, to include: (1) material that may be held up in uninstalled equipment and facilities from previous operations and in equipment received from other facilities, (2) laboratory chemicals, (3) analysis of samples <sup>e</sup> , or (4) instrument calibration and check sources.
	94	Sealed source		50 Ci	Instrument calibration sources, NDA
		Sealed glass ampules		3 Ci	Instrument calibration sources, NDA
		Unsealed sources		0.5 Ci	Laboratory chemicals Analysis of samples <sup>e</sup>
D. By-Product Material	94	Any	Any	That resulting from the feed of recycled or FSU <sup>e</sup> uranium	Process contaminants and wastes, material held in equipment from previous operations
	3-89, 91	Sealed source		1 Ci with no single isotope to exceed 100 mCi, except as noted below	Calibration, instrument internal source Instrument calibration and check sources
		Unsealed source		1 Ci with no single isotope to exceed 100 mCi, except as noted below	Laboratory chemicals Analysis of samples <sup>e</sup>

Table 1-3. (Continued)

Type of Material	Atomic Number	Physical State	Chemical Form	Description	Possession Limit
	27Co-57	Sealed Source		Calibration, internal instrument standard, NDA	10 Ci
	27Co-60	Sealed Source		Calibration, NDA, Process sources	450 Ci
		Unsealed Source		Laboratory chemicals Analysis of samples <sup>e</sup>	0.5 Ci
	28Ni-63	Sealed Source		Process sources, internal instrument standards	10 Ci
	38Sr-90	Sealed Source		Calibration	0.5 Ci
		Unsealed Source		Laboratory chemicals, Analysis of samples <sup>e</sup>	0.5 Ci
	43Tc-99	Sealed Source		Calibration	10 Ci
		Unsealed Source		Laboratory chemicals, Analysis of samples <sup>e</sup>	5 Ci
		Any	Any	Process contaminants and wastes, material held in equipment from previous operations	That resulting from the feed of recycled or FSU <sup>g</sup> uranium
	55Cs-137	Sealed Source		Calibration, NDA, Process sources	2,000 Ci
		Unsealed Source		Laboratory chemicals Analysis of samples <sup>e</sup>	0.5 Ci
	61Pm-147	Sealed Source		Calibration	0.5 Ci
	70Yb-169	Sealed Source		Calibration, NDA	5.0 Ci
	81Tl-207	Sealed Source		Calibration	1.0 Ci
	88Ra-226	Sealed Source		Calibration	15 Ci

Table 1-3 (Continued)

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
	93, 96, 97, 99, 100	Sealed source Unsealed source		0.5 Ci 1.0 Ci	Calibration Laboratory chemicals Analysis of samples*
	93, 95-100	Any	Any	That resulting from the feed of recycled or FSU uranium*	Process contaminants and wastes, material held in equipment from previous operations
	95	Sealed source Unsealed source	Oxides, metals Oxides, metals, solutions	15 Ci 0.5 Ci	Calibration, process source Analysis of samples* Laboratory chemicals
	98	Sealed source Unsealed source	Oxides, metals Oxides, metals, solutions	10 Ci 0.5 Ci	Calibration, NDA Analysis of samples* Laboratory chemicals

a. MTU - Metric Tons Uranium

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b. See 10 CFR Part 76 definitions: Special nuclear material means: (1) Plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of Section 51 of the act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched in any of the foregoing, but does not include source material.

c. FSU meets the ASTM Standard C996, Standard Specification for Uranium Hexafluoride Enriched to Less Than 5 percent <sup>235</sup>U; UF<sub>6</sub> for enrichment meets the ASTM Standard C787, Standard Specification for Uranium Hexafluoride for Enrichment.

d. Recycled uranium includes the feed and processing of Paducah Product and the "stockpile" UF<sub>6</sub> transferred from DOE to USEC for enrichment.

e. "Analysis of samples" refers to the analysis of samples related to enrichment activities or site remediation, (PORTS, PGDP, DOE-OR) activities utilizing existing facilities and analytical techniques to process low-level radioactivity samples bounded by the possession limits stated in this table.

f. Except for Paducah Product and the "stockpile" UF<sub>6</sub> transferred from DOE to USEC for enrichment, uranium to be fed to the cascade will meet the requirements of ASTM Standard C996, "Standard Specification for Uranium Hexafluoride Enriched to Less Than 5% <sup>235</sup>U" or ASTM Standard C787, "Standard Specification for Uranium Hexafluoride for Enrichment" for reprocessed UF<sub>6</sub>. All other uranium that does not meet the requirements of ASTM C996 or C787 for reprocessed UF<sub>6</sub> may be accepted for storage and subsequent dispositioning but will not be introduced to the cascade, with the exception of small amounts (e.g., 50 pounds UF<sub>6</sub>) associated with sampling, subsampling, and analyses required to establish receiver's values.

g. These possession limits do not include material in USEC leased space from previous DOE operations to include retained inventory of uranium plated out on the inside surfaces of both shutdown and operating equipment in the X-326 facility, specific components in the X-326 cascade that need to be removed for maintenance or other operational purposes; material and equipment such as alumina traps, seal exhaust oil and GP containers from always-safe vacuums that are generated as part of ongoing operations in X-326; or material held up in X-705 equipment (some of which may have to be removed for maintenance).

FSU - Former Soviet Union

Table 1-4. Authorized uses of NRC-regulated materials.

Material Class	Authorized Use
A. Source Material, Element 92 <sup>a, b</sup>	<ol style="list-style-type: none"> <li>1. Enrichment of uranium up to 10 percent enrichment by weight <sup>235</sup>U</li> <li>2. Receipt, storage, inspection, and acceptance sampling of cylinders containing uranium</li> <li>3. Filling and storage of cylinders of natural uranium and uranium depleted in <sup>235</sup>U</li> <li>4. Cleaning and inspection of cylinders used for the storage and transport of process product and tails containing source or SNM</li> <li>5. Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products</li> <li>6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes</li> <li>7. Radiation protection, process control and environmental sample collection, analysis, instrument calibration, and operation checks</li> <li>8. Maintenance, repair, and replacement of process equipment</li> <li>9. Laboratory analysis and testing</li> <li>10. Heating cylinders and feeding contents into the diffusion process</li> <li>11. Controlled feeding of cylinders</li> <li>12. Transfer between cylinders</li> </ol>
B. Source Material, Element 90	<ol style="list-style-type: none"> <li>1. Calibration and use of portable radiation protection and fixed laboratory equipment</li> <li>2. Laboratory analysis and testing</li> <li>3. Process, characterize, package, ship, or store low-level radioactive and mixed wastes</li> </ol>

Table 1-4. (Continued)

Material Class	Authorized Use
C. Special Nuclear Material <sup>1a,b</sup>	<ol style="list-style-type: none"> <li>1. Filling, assay, storage, and shipment of cylinders and other NCS approved containers containing uranium enriched up to 10 percent by weight <sup>235</sup>U</li> <li>2. Nondestructive testing and analyses of product and process streams</li> <li>3. Receipt, storage, inspection, and acceptance sampling of cylinders containing uranium enriched up to 10 percent by weight <sup>235</sup>U</li> <li>4. Cleaning and inspection of cylinders used for the storage and transport of process feed, product, and tails containing source or SNM</li> <li>5. Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products</li> <li>6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes</li> <li>7. Radiation protection, process control and environmental sample collection, analysis, instrument calibration, and operation checks</li> <li>8. Maintenance, repair, and replacement of process equipment</li> <li>9. Laboratory analysis and testing</li> <li>10. Heating cylinders and feeding contents into the diffusion process</li> <li>11. Controlled feeding of cylinders</li> <li>12. Transfer between cylinders</li> <li>13. That remaining in equipment and facilities as a result of previous operations</li> </ol>

Table 1-4. (Continued)

Material Class	Authorized Use
D. By-product Material, Elements 3-89, 91	<ol style="list-style-type: none"> <li>1. Radiation protection, process control, and environmental sample collection, analysis, instrument calibration, and operation checks</li> <li>2. Laboratory analysis and testing</li> <li>3. Nondestructive testing of product and product streams</li> <li>4. Storage of process wastes containing uranium, transuranics, process contaminants, and decay products</li> <li>5. That remaining in equipment and facilities as a result of feeding recycled uranium</li> <li>6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes</li> </ol>
Elements 93, 95 to 100	<ol style="list-style-type: none"> <li>1. Calibration and use of portable radiation protection and fixed laboratory equipment</li> <li>2. Laboratory analysis and testing</li> <li>3. Nondestructive testing of product and product streams</li> <li>4. Storage of process wastes containing uranium, transuranics, process contaminants, and decay products</li> <li>5. That remaining in equipment and facilities as a result of feeding recycled uranium</li> <li>6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes</li> </ol>
<sup>43</sup> Tc <sup>99</sup> Tc	<ol style="list-style-type: none"> <li>1. That remaining in equipment and facilities as a result of feeding recycled uranium</li> <li>2. Storage of process wastes as a result of feeding recycled uranium</li> </ol>

- Except for Paducah Product and the "stockpile" UF<sub>6</sub> transferred from DOE to USEC for enrichment, uranium to be fed to the cascade will meet the requirements of ASTM Standard C996, "Standard Specification for Uranium Hexafluoride Enriched to Less Than 5% <sup>235</sup>U" or ASTM standard C787, "Standard Specification for Uranium Hexafluoride for Enrichment" for reprocessed UF<sub>6</sub>. All other uranium that does not meet the requirements of ASTM C996 or C787 for reprocessed UF<sub>6</sub> may be accepted for storage and subsequent dispositioning but will not be introduced to the cascade, with the exception of small amounts (e.g., 50 pounds UF<sub>6</sub>) associated with sampling, subsampling, and analyses required to establish receiver's values.
- Includes the feed and processing of Paducah Product and the "stockpile" UF<sub>6</sub> transferred from DOE to USEC for enrichment.

## Appendix A

### Applicable Codes, Standards, and Regulatory Guidance

This Appendix lists the various industry codes, standards, and regulatory guidance documents which have been referenced in certification correspondence. The extent to which PORTS satisfies each code, standard, and guidance document is identified below, subject to the completion of applicable actions required by the Compliance Plan.

#### 1.0 American National Standards Institute (ANSI)

##### 1.1 ANSI N14.1, Uranium Hexafluoride - Packaging for Transport, 2001 Edition

PORTS satisfies the requirements of this standard, except for those portions superseded by Federal Regulations, with the following clarifications:

- a. Text Deleted.
- b. Cylinders and valves that were already owned and operated by PORTS and were not purchased to ANSI N14.1- 2001 were manufactured to meet the version of the ANSI standard or specification committed to at the time of the placement of the purchase order and satisfy only Sections 4, 5, 6.2.2 - 6.3.5, 7, and 8 of ANSI N14.1-2001.
- c. Text Deleted.
- d. Text Deleted.

- e. Tinning of cylinder valve and plug threads: ANSI N14.1 - 1995 and prior editions requires the use of ASTM B32 50A, a 50/50 tin/lead solder alloy described in the 1976 and previous editions of the ASTM standard. ANSI N14.1 - 2001 requires that cylinder valve and plug threads be tinned with solder alloys meeting the requirements of ASTM B32 with a minimum tin content of 45% such as alloy SN50. Some cylinder valve and plug threads that were purchased to meet the 1990 or the 1995 edition of the standard were tinned using a method that is conservative with respect to the 2001 edition of the standard (minimum tin content of 46% versus 45%) rather than meeting the 1990 or 1995 edition of the standard.
- f. Cylinder Valve Protectors (CVPs): For 48X, 48Y and 48G cylinders; the 1990 standard requires these devices to be fabricated from ASTM A285 Grade C or A516 steel. The 2001 standard requires these devices to be fabricated from weldable carbon steel with a minimum tensile strength of 45,000 lbs/in<sup>2</sup> and a maximum carbon content of 0.26%, such as ASTM A-36 steel. Likewise, the set screws are to be manufactured to specific requirements for each CVP. (Addendum 1 to ANSI N14.1-2001 also allows an alternate cylinder valve protector design.) Cylinders in use at PORTS may meet the CVP design allowed by ANSI N14.1-1990 or either of the CVP designs allowed by ANSI N14.1-2001. Alternately, the CVPs for any cylinders in use at PORTS may be steel, similar in design to those specified in ANSI N14.1-1990 and 2001, and meet the intent of this standard. Set screws that are employed in these CVPs are also steel and are manufactured in accordance with the ANSI N14.1-1990 or 2001 design, a derivative of this design, or a grade 5 bolt.
- g. Use of steel or aluminum-bronze plugs in UF<sub>6</sub> cylinders is acceptable at PORTS for the following operations: heating, feeding, sampling, filling, transferring between cylinders and onsite transport and storage.
- h. None of the Model 48HX cylinders in use by USEC were manufactured to the ANSI N14.1-2001 standard and this model of cylinder is no longer in production. However, the 2001 edition of this standard mistakenly lists the minimum volume for this cylinder as 139 ft<sup>3</sup> and the maximum fill limit at 26,840 pounds. Previous editions of the standard list the minimum volume for this cylinder type as 140 ft<sup>3</sup> and the maximum fill weight as 27,030 pounds. Model 48HX cylinders at PORTS will comply with the volume requirements and fill limits that are listed in the 1990/1995 editions of ANSI N14.1 and are also flowed down into the TSRs.
- i. Use of cylinders (procured under ANSI N14.1, 2001 Edition) with cylinder lifting lug corners having a 1/8" x 45 degree chamfer rather than a 3/4" corner radius (as specified in the ANSI N14.1, 2001 Edition) is acceptable at PORTS for all cylinder operations.

For references to this standard, see SAR Section 3.2, Table 3.2-2, Section 3.3.1.3.2.4, Section 3.8, Section 4.3.2.2.

- 1.2 ANSI/ANS 3.1, Selection, Qualification, and Training of Personnel for Nuclear Power Plants, 1987 Edition

PORTS satisfies only the following section of this standard:

Section 4.3.3 - The qualifications of the Radiation Protection Manager identified in SAR Section 6.1 satisfy the requirements of this section of the standard.

- 1.3 ANSI/ANS 3.2, Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants, 1994 Edition

The extent to which PORTS satisfies the requirements of this standard is outlined in SAR Section 6.11.1 and Appendix B to SAR Section 6.11.

- 1.4 ANSI/ANS 6.4, Guidelines for Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants, 1977 Edition

PORTS satisfies the requirements of this standard for the Radiation Calibration (RADCAL) facility.

For references to this standard, see SAR Section 3.5.1.1.1.1.

- 1.5 ANSI/ANS 8.1, Nuclear Criticality Safety in Operations With Fissionable Materials outside Reactors, 1983 Edition

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Sections 4.3.2.6, 5.2.2.1, 5.2.2.3, 5.2.3.1 -Mass, 5.2.3.1-Concentration, 5.2.3.2, 5.2.4.2, and Table 6.9-1.

- 1.6 ANSI/ANS 8.3, Criticality Accident Alarm System, 1986 Edition <sup>1</sup>

PORTS satisfies the requirements of this standard with the following exceptions:

Section 4.4.2 - An alarm signal with a complex sound wave or modulation is not provide.

Section 4.4.4 - A limit on the sound level emitted from the signal generator is not provided.

Section 4.5.3 - Emergency power supplies for AQ and NS alarm systems are not provided. Abattery backup serves as the backup power supply for the cluster and local nitrogen horn.

Section 5.3 - The CAAS is not designed to withstand seismic stresses.

Section 5.7.2 - This section recommends that the alarm trip point be more than 10 mrad/hr above normal background. PORTS uses a lower value because normal neutron background is small.

Section 6.3 - The testing frequency for the clusters is specified in the Technical Safety Requirements.

Section 6.4 - The testing frequency for the audible alarms is specified in the Technical Safety Requirements.

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<sup>1</sup> In describing criticality accident conditions, SAR Chapter 4 makes comparisons to ANSI/ANS 8.3, 1979 Edition. Commitments to the 1986 Edition bound these comparisons.

Section 7.1 - Posting in accordance with this section is not provided. Instructions to site personnel regarding response to alarm signals are provided in General Employee Training.

Section 7.2.3 - The testing frequency for the audible alarms is specified in the Technical Safety Requirements. Additionally, evacuation and familiarization drills are conducted in accordance with the Emergency Plan.

For references to this standard, see SAR Sections 3.6.2.2.1.1; 3.8, 4.3.2.6.

- 1.7 ANSI/ANS 8.5, Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material, 1986 Edition

PORTS satisfies the following sections of this standard:

Sections 4.1, 4.3, and 4.4 - Satisfy the requirements of these sections if raschig rings are replaced. See SAR Section 5.2.3.1 - Neutron Absorption.

Sections 4.1, 6.2.3, 6.3.2, and 6.4 - Satisfy the testing requirements in these sections if a release occurs exposing existing rings to a corrosive environment. See SAR Section 5.2.3.1 - Neutron Absorption.

Section 6.1 - Satisfy the surveillance requirements in this section as described in the Technical Safety Requirements, SAR Section 5.2, and Nuclear Criticality Safety Approvals (NCSAs). The inspection for raschig rings damage described in SAR Section 5.2 is accomplished by inspecting and replacing rings when the cumulative addition would become equal to 10% of the original loading.

- 1.8 ANSI/ANS 8.7 (N16.5), Guide for Nuclear Criticality Safety in the Storage of Fissile Material, 1975 Edition

PORTS satisfies the requirements of this standard with the following exceptions/clarifications:

Section 4.2.6 - Fire protection systems are installed throughout the process buildings where flammable liquids are used in operating equipment. Individual cell housings do not contain fire protection systems.

Section 5.1 - PORTS does not implement the unit mass limits described in this section. Mass limits are defined in Nuclear Criticality Safety Approvals (NCSAs) and Nuclear Criticality Safety Evaluations (NCSEs).

For references to this standard, see SAR Sections 5.2.2.1 and 5.2.4.2.

- 1.9 ANSI/ANS 8.19, Administrative Practices for Nuclear Criticality Safety, 1984 Edition

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Sections 5.2.2.1 and 5.2.4.2.

- 1.10 ANSI/ANS 8.20, American National Standard for Nuclear Criticality Safety Training, 1991 Edition

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Sections 6.6.1.1, 6.6.4.2, and 6.6.11.

- 1.11 ANSI N13.22, Bioassay Programs for Uranium, 1995 Draft

PORTS satisfies only Section 6.1.1 of this standard regarding the calculational method for action levels for the PORTS internal dosimetry program.

For references to this standard, see SAR Section 5.3.2.3.

- 1.12 ANSI B30.2, Overhead and Gantry Crane Design & Inspection, 1990 Edition (including Addenda A, 1991)

PORTS satisfies the requirements of the following sections of this standard for liquid UF<sub>6</sub> handling cranes and enrichment process building cranes used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

Section 2-2.1.1 - all

Section 2-2.1.2 - all

Section 2-2.1.3 - all except for paragraphs (6), (8), and (9)

Section 2-2.2.2 - only paragraphs (a), (b)(1), and (b)(4)

Section 2-2.3.1 - all

Section 2-2.4.1 - all

- 1.13 ANSI B30.9, Slings, 1990 Edition (including Addenda A, 1991)

PORTS satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF<sub>6</sub> cylinders and used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

Section 9-1.6 - all

Section 9-2.8.1 - all

Section 9-2.8.2 - all

- 1.14 ANSI B30.10, Hooks, 1987 Edition (up through Addenda C, 1992)

PORTS satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF<sub>6</sub> cylinders and used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

Section 10-1.2.1.1 - all  
Section 10-1.2.1.2 - all  
Section 10-1.2.1.3 - all

1.15 ANSI B30.20, Below the Hook Rigging Devices, 1993 Edition

PORTS satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF<sub>6</sub> cylinders and used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

Section 20-1.3 - all  
Section 20-1.4.1 - only paragraphs (a) and (b)

1.16 ANSI NB-23, National Board Inspection Code, 1992 Edition

PORTS satisfies the requirements of this code as described below:

Autoclave shell and head are visually inspected to section U-110.1 of this standard.

PORTS utilizes Chapter V of this code as guidance to develop the inspection program for ASME pressure vessels.

1.17 ANSI N323, Radiation Protection Instrumentation Test and Calibration, 1978 Edition.

PORTS satisfies the requirements of this standard except as described in SAR Section 5.3.5.

For references to this standard, see SAR Sections 3.5.1.1.1.1 and 5.3.5.

1.18 ANSI N509, Nuclear Power Plant Air Cleaning Units and Components, 1989 Edition

New and existing fixed HEPA filter systems needed to ensure compliance with release limits or to control worker radiation exposure satisfy the requirements of this standard with the following exceptions and clarifications:

Section 5.2 - Do not satisfy. No credit is taken for adsorbers.

Section 5.5 - Do not satisfy requirements for air heaters.

Section 8.0 - Quality assurance requirements for applicable systems are identified in SAR Section 3.8 and the Quality Assurance Program Description

Appendix A - Do not sample adsorbents.

Appendix B - Do not use allowable leakage guidance.

Appendix C - Do not use manifold design guidelines.

Appendix D - The manifold qualification program uses this appendix as guidance only.

For references to this standard, see SAR Section 5.1.1

**1.19 ANSI N510, Testing of Nuclear Air Treatment Systems, 1989 Edition**

New and existing fixed HEPA filter systems that satisfy the requirements of ANSI N509 and are needed to ensure compliance with release limits or to control worker radiation exposure satisfy the requirements of this standard with the following exceptions and clarifications:

Section 6.0 - Only satisfy this section for new seal-welded duct systems or for connections to a system where this section has been previously applied.

Section 7.0 - Do not use guidance for monitoring frame pressure leak tests.

Existing fixed HEPA filter systems that do not satisfy the requirements of ANSI N509 will be tested using the requirements of this standard or another industry accepted standard as guidance only.

For references to this standard, see SAR Sections 5.1.1 and 5.3.2.10.

**1.20 ANSI N543, General Safety Standard for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, 1974 Edition**

PORTS satisfies Sections 3.2, 7, and 8.1.2 of this standard for the X-326 Radiographic Facility, as they apply to Enclosed Installations.

For references to this standard, see SAR Section 3.5.1.6.1.

**2.0 American Society of Mechanical Engineers (ASME)**

**2.1 ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities, 1989 Edition**

PORTS satisfies the requirements of this standard, including Basic and Supplementary Requirements, with exceptions and clarifications identified in the Quality Assurance Program Description. See also SAR Sections 6.6.12, 6.8.1 and 6.8.2 and Section 7.5 of the Emergency Plan.

**2.2 ASME Boiler and Pressure Vessel Code, 1995 Edition**

PORTS satisfies the following sections of this code as clarified below:

Section VIII - The following pressure vessel components and systems satisfy the requirements

of Section VIII of this code for the edition in effect at the time of fabrication: freezer/sublimator; condenser/reboiler; autoclave; cell coolant condenser; nitrogen system (relief devices only); cell coolant pressure relief;  $\text{ClF}_3$  and  $\text{F}_2$  tanks used in X-330/X-333 and X-342, respectively; and  $\text{UF}_6$  cylinders except that  $\text{UF}_6$  cylinders do not have pressure relief devices.

Section IX - PORTS satisfies the requirements of Section IX for the components identified above for Section VIII.

For references to this standard, see SAR Sections 3.1.3.2.1.1, 3.1.3.2.2.1, 3.2.1.1.1.2.11, 3.2.1.3.1.2.11, 3.4.3.3, and 3.9.6.

### **3.0 National Fire Protection Association (NFPA)**

#### **3.1 NFPA 10, Portable Fire Extinguishers, 1990 Edition**

As described in SAR Section 5.4.3, the requirements of this standard were used as guidance only in determining the size, selection, and distribution of portable fire extinguishers. PORTS will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the Authority Having Jurisdiction (AHJ).

For references to this standard, see SAR Sections 5.4.1 and 5.4.3.

#### **3.2 NFPA 13, Standard for the Installation of Sprinkler Systems, 1989 Edition**

The requirements of this standard were used as guidance only for the design and installation of wet and dry pipe automatic sprinkler systems. In addition, the process buildings meet the definition of Ordinary Hazard Occupancies (Group 2) as stated in this standard and the fire protection system exceeds the sprinkler discharge density for this type of occupancy. PORTS will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Sections 3.3.1.8.4, 3.5.1.1.1.2, 3.6.1.2.1, 3.8, and 5.4.1, 5.4.1.1.

#### **3.3 NFPA 15, Water Spray Systems, 1990 Edition**

PORTS will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Section 5.4.1.

#### **3.4 NFPA 24, Private Fire Service Mains, 1992 Edition**

As described in SAR Section 3.6.1.1.2.4, all underground piping for the high-pressure fire water

system was installed and is maintained using the requirements of this standard for guidance only. PORTS will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Sections 3.6.1.1.2.4 and 5.4.1.

**3.5 NFPA 30, Flammable Liquids, 1990 Edition**

As identified in SAR Table 3.5-2, aboveground storage tanks were installed using the requirements of this standard for guidance only. In addition, as described in SAR Section 5.4.1.1, the requirements of this standard are used as guidance only for the handling of flammable liquids. PORTS will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Table 3.5-2 and Sections 5.4.1 and 5.4.1.1.

**3.6 NFPA 101, Life Safety Code, 1991 Edition**

PORTS uses the requirements of this standard as guidance only for the review of emergency egress paths.

For references to this standard, see SAR Section 5.4.1.2.

**3.7 NFPA 232 (and 232 AM), Standard for the Protection of Records, 1986 Edition**

As described in SAR Section 6.10.1.8, there are several acceptable methods for the storage of permanent records. If the NFPA 232 (or 232 AM) method of storage in 2-hour-rated containers is used, any exceptions to this standard will be documented and justified by the AHJ.

**4.0 NRC Regulatory Guidance**

**4.1 Regulatory Guide 1.59, Design Basis Floods for Nuclear Power Plants, Revision 2, 1977**

The extent to which PORTS satisfies the requirements of this regulatory guide will be determined as part of the SAR Upgrade activity.

For references to this regulatory guide, see SAR Sections 2.4.3 and 2.4.3.2.

- 4.2 Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50 Appendix I, October 1977.

PORTS uses the food chain models in this standard to evaluate public radiation dose due to waterborne radioactive effluent via potable water and aquatic food pathways, as described in SAR Section 5.1.3.2.

For references to this standard, see SAR Section 5.1.3.2.

- 4.3 Regulatory Guide 3.34, Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Uranium Fuel Fabrication Plant, Revision 1

PORTS uses formulas from this document to calculate doses from criticality accidents, as described in SAR Section 4.1. Other methods may also be used to calculate these doses.

For references to this standard, see SAR Sections 4.3.2.6.

- 4.4 Regulatory Guide 8.13, Instructions Concerning Prenatal Radiation Exposure, Revision 2

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Section 5.3.2.2.

- 4.5 Bulletin 91-01, Reporting Loss of Criticality Safety Controls

PORTS satisfies the requirements of this NRC Bulletin as identified in SAR Table 6.9-1.

- 4.6 Regulatory Guide 3.67, Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities

PORTS uses examples provided in the Regulatory Guide, Appendix A, to develop Emergency Action Levels.

For references to this regulatory guide, see the Summary and Section 3.0 of the Emergency Plan.

- 4.7 Regulatory Guide 5.59, "Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance."

PORTS uses examples from the Regulatory Guide to develop Physical Security Plans for the Transportation of Special Nuclear Material of Low Strategic Significance and the Physical Security Plans for the Protection of Special Nuclear Material of Low Strategic Significance.

For reference to this regulatory guide, see Chapter 1, Introduction of the Physical Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance and Chapter 1, Introduction of the Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance.

**5.0 Other Codes, Standards, and Guidance Documents**

**5.1 USEC-651, Uranium Hexafluoride: A Manual of Good Handling Practices, Revision 7, January 1995**

USEC-651 supersedes ORO-651, Revision 6. PORTS satisfies only the following sections of USEC-651 as clarified below:

Section 3.3 - all; cylinders with heels greater than Table 3 limits are shipped in accordance with the requirements of 49 CFR 173.

Section 5.2 - all except for paragraph 5.2.2. Not all PORTS cylinders have internal volumes measured by the manufacturer.

Section 5.3 - all

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Section 5.4 - all

Section 7.1 - only the sixth paragraph

Section 10.0 - all except as follows:

First paragraph - Not all PORTS shipping cylinders meet the requirements of the most recent version of ANSI N14.1 (1995 Edition). These cylinders were manufactured prior to the date of ANSI N14.1-95. (See item 1.1, ANSI N14.1)

Fourth paragraph - Older PORTS cylinders may not have a measured volume that has been certified by the manufacturer. (See item 1.1, ANSI N14.1).

Section 13.0 - all

For references to this document, see SAR Sections 3.2.2.6 - Cylinder Change; 3.8; and the Transportation Security Plan, Section 6.4.

- 5.2 NCRP 112, Calibration of Survey Instruments Used in Radiation Protection for the Assessment of Ionizing Radiation Fields and Radioactive Surface Contamination

NCRP 112 is an example of a nationally recognized guidance document that may be used to establish calibration requirements for radiological protection instruments. See SAR Section 5.3.5.

- 5.3 Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, undated

PORTS uses the data contained in Tables 2-1 and 2-2 of this document to calculate dose conversion factors for radionuclides of concern. This data is also used to calculate the Derived Air Concentrations (DACs) listed in SAR Table 5.3-5.

For references to this standard, see SAR Section 5.3.2.3.

- 5.4 SNT-TC-1A, Qualification and Requalification of Nondestructive Examination Personnel, 1980 Edition

PORTS satisfies the requirements of this standard with clarifications identified in Section 2.2.4 of the Quality Assurance Program Description.

- 5.5 EPA 400-R-92-001, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents

PORTS satisfies the requirements of only Section 2.5 of this document.

For references to this standard, see Section 5.5.1.2 of the Emergency Plan.

5.6 ICRP-26, Internal Dose, 1977

The concepts described in this standard were used as guidance only in developing the PORTS radiation protection program described in SAR Section 5.3. PORTS is required to meet the requirements of 10 CFR 20.

For references to this standard, see SAR Section 5.3.2.3.

5.7 ICRP-30, Limits for Intakes of Radionuclides by Workers, 1978

The concepts described in this standard were used as guidance only in developing the PORTS radiation protection program described in SAR Section 5.3. PORTS is required to meet the requirements of 10 CFR 20.

For references to this standard, see SAR Section 5.3.2.3, and Table 5.3.10.

5.8 ANSI/ISA-S67.04, Setpoints for Nuclear Safety Related Instrumentation, 1988 Edition

PORTS satisfies the requirements of this standard for setpoint calculations for Q systems.

5.9 ASTM C787, Specification for Uranium Hexafluoride for Enrichment, 1990 Edition

PORTS satisfies the requirements of this standard as described in SAR Tables 1-3 (footnotes c and f) and 1-4 (footnote a) with the following clarification:

Production from the cascade is considered "material-in-process" and, on occasion, may be refeed to the cascade; as such, it is not covered by the feed restrictions described in this standard.

5.10 ASTM C996, Standard Specification for Uranium Enriched to less than 5% <sup>235</sup>U, 1990 Edition

PORTS satisfies the requirements of this standard as described in SAR Tables 1-3 (footnotes c and f) and 1-4 (footnote a) with the following clarification:

Production from the cascade is considered "material-in-process" and, on occasion, may be refeed to the cascade; as such, it is not covered by the feed restrictions described in this standard.

5.11 U.S. Department of Transportation, North American Emergency Response Guidebook

PORTS uses the initial isolation and protective action distances in this guidebook for determining emergency action levels.

For the reference to this guidebook, see Section 3.0 of the Emergency Plan.

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**CHAPTER 2**

**SITE CHARACTERISTICS OF THE PORTSMOUTH**

**GASEOUS DIFFUSION PLANT (PORTS)**

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## **2. SITE CHARACTERISTICS OF THE PORTSMOUTH GASEOUS DIFFUSION PLANT (PORTS)**

This chapter provides information on the location and site characteristics of the Portsmouth Gaseous Diffusion Plant (PORTS) as specified in 10 CFR 76.35(a)(8). The purpose is to provide a description of site characteristics needed to support the assumptions used in determining the impacts of normal operation, emergency planning, and the hazard and accident analysis contained in Chapter 4. These assumptions include the contribution of external and natural phenomena to initiation of events and the site-related assumptions used in evaluating accident consequences. This chapter includes descriptions of:

1. The location of the site and facility and its proximity to public and other facilities (Section 2.1),
2. Local population location and density (Section 2.1),
3. Nearby industrial, transportation, and military activities (Section 2.2), and
4. The historical basis for site characteristics in meteorology, hydrology, geology, and seismology (Sections 2.3 through 2.6).

### **2.1 GEOGRAPHY AND DEMOGRAPHY OF THE SITE**

This section describes the PORTS site location and description, surrounding populations, and use of nearby land and waters.

#### **2.1.1 Site Location**

PORTS is located in rural Pike County, a sparsely populated area in south central Ohio. The facility is about 70 miles south of Columbus, Ohio, and 75 miles east of Cincinnati, Ohio, the two closest metropolitan areas. The cities of Portsmouth and Chillicothe, Ohio, are located approximately 25 miles from the facility (south and north, respectively). The location of the site, relative to major cities in Ohio, is depicted in Figure 2.1-1. Figures 2.1-2 and 2.1-3 depict the nearby communities of Piketon and Waverly, both north of PORTS, along with major highways, railways, and bodies of water.

The Scioto River Valley is 1 mile west of the facility. The Scioto River (Figure 2.1-3) is a tributary of the Ohio River, and their confluence is approximately 20 miles south of PORTS. With the exception of the Scioto River floodplain, which is farmed extensively, the area around PORTS consists of marginal farmland and forested hills.

The specific location of PORTS (i.e., a central point of the facility near the process buildings) is latitude 39°0'30" N and longitude 83°0'00" W. In Universal Transverse Mercator coordinates, this location is N 4,319,410 m and E 326,829 m (Zone 17).

### **2.1.2 Site Description**

PORTS is located on a 3,708-acre Department of Energy (DOE) Reservation as shown in Figure 2.1-3. The plant occupies 500 acres and consists of 109 buildings. Figure 2.1-4 identifies the primary buildings at the PORTS site. The site consists of facilities and areas leased to USEC and certified, leased to USEC and uncertified, subleased to USEC, Inc. and uncertified, and retained by DOE (i.e., non-leased). Activities conducted within facilities leased to USEC and NRC certified, excluding non-leased facilities and access and egress thereto, are conducted in accordance with this Application. Also, activities conducted by USEC and its agents in areas within the perimeter road, excluding non-leased areas and access and egress thereto, will also be conducted in accordance with this Application. DOE will regulate under the Gas Centrifuge Enrichment Plant Leased Premises Regulatory Oversight Agreement (GCEPROA) the activities performed by USEC in the GCEP buildings and the activities performed by USEC, Inc. in the Subleased GCEP buildings until USEC, Inc. activities are regulated by the NRC. DOE will self-regulate DOE activities conducted in non-leased areas and leased areas in accordance with applicable DOE requirements. A listing of facilities leased to the United States Enrichment Corporation (USEC) and those facilities retained by DOE at the PORTS site, are shown in Figures 2.1-5a and 2.1-5b. Some leased facilities at the site contain areas that are deleased. A listing of leased facilities is maintained onsite and will be updated on annual basis with the Safety Analysis Report (SAR) update.

#### **2.1.2.1 Topography**

South central Ohio lies in the steep to gently rolling Appalachian foothills. The elevation of the PORTS site is approximately 120 ft above the Scioto River flood plain. The site is located in the valley of a tributary of the ancient Teays River.

The predominant landform in the site area is the relatively broad, level, filled valley of a preglacial river. This valley is oriented north-to-south and is bounded on the east and west by ridges or low-lying hills. Another significant landform is the small valley formed by Little Beaver Creek, which flows in a northwesterly direction across PORTS just north and east of the main plant area.

#### **2.1.2.2 Vegetative Cover**

The area within the perimeter road (Figure 2.1-4) is a fully developed industrial area. As such, the grounds are maintained as lawns, and support various species of grasses and herbaceous divots. The vegetation of surrounding Pike County consists primarily of hardwood forests. Field crops constitute the other major category of vegetative cover in the surrounding area.

#### **2.1.2.3 Onsite Transportation and Transmission Systems**

No U.S. or state highways enter the PORTS reservation. Vehicular traffic can enter the reservation from all four sides through several access roads that intersect the plant's perimeter road; these roads are shown in Figure 2.1-4.

The Seaboard System Railway, Inc. (CSX), provides rail access to the PORTS site. This CSX line intersects rail lines supported by CSX and Norfolk and Southern Railway (N&S).

Although PORTS once maintained a landing strip for air transportation, the strip is now obstructed with earthen berms. The southern end of the landing strip is maintained as a helicopter pad. The Plant Shift Superintendent coordinates helicopter approaches to ensure they do not fly over process buildings

or hazardous material storage areas.

Onsite utility transmission systems include those for communications, water, electricity, natural gas and wastewater. Major waste-water sources and systems are shown in Figure 2.1-6. Discharge of waste-water is made to the Scioto River and its tributaries, Little Beaver Creek and Big Run Creek.

Electricity is provided by the Ohio Valley Electric Company (OVEC) through its Don Marquis Substation located on the northwest side of PORTS just outside the plant's security area on the DOE Reservation. Fuel and flammable gases (e.g., propane and acetylene) are contained in commercial cylinders and are delivered to PORTS by truck. The cylinders are stored at area X-742, the gas cylinder storage facility (see Figure 2.1-4).

#### **2.1.2.4 Site Boundary**

The entire DOE Reservation on which PORTS is located is marked and bounded by signs and fences, either chain link or barbed wire (in the wooded areas). Where roads cross the boundary, gates are in place to serve as barriers if needed. DOE controls activities in and regulates access to this reservation area. The DOE reservation and its boundaries are identified in Figure 2.1-3.

Most buildings and activities of PORTS are located within the next level of control--a Controlled Access Area/Limited Area surrounded by a security fence as described in Gaseous Diffusion Plant Security Program, Chapter 1, Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic, Section 4.2.1. Access to buildings within this area is gained only with an appropriate badge. Activities in this area are limited to plant operation, maintenance, management, and associated construction activities.

#### **2.1.2.5 Boundaries for Establishing Effluent Release Limits**

The controlled area is as defined in 10 CFR Part 20 and is the area outside the restricted area but inside the site (reservation) boundary, access to which can be limited by USEC for the purposes of plant protection, security, emergency preparedness and radiation protection. This boundary is identified in Figure 2.1-3. Adequate measures to limit access to the controlled area, such as utilizing existing gates, can be implemented as directed in site procedures. Some areas within the reservation, particularly in the limited area, currently have ground contamination caused by prior DOE operations. Health Physics maintains a listing and data for areas currently identified.

#### **2.1.3 Population**

#### **2.1.3.1 On-Site Population**

Total employment of the operating contractor was 1294 as of August 2002. In addition, there were 397 USEC, DOE and DOE contractor and tenant employees onsite. Approximately 68 employees of OVEC work at the neighboring office building on the main access road (within the DOE Reservation), while the OVEC substation (Don Marquis Substation) is not staffed.

In addition to the employees discussed above, other persons may be onsite for various reasons. These individuals include construction contractors, consultants, vendors, maintenance workers, and visitors. It is estimated that approximately 550 such persons are at PORTS each weekday.

#### **2.1.3.2 Area Residential Population**

The permanent residential population of Pike County was 27,695 in 2000. The population of Pike County increased 19.3 percent between 1970 and 1980, 6.3 percent between 1980 and 1990 and 14.2 percent between 1990 and 2000 (U.S.

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Bureau of the Census, 1973; 1988; 1992; 2000). Current population density in the county is approximately 63 people/square mile. Population growth has occurred largely in the unincorporated areas of the county. Waverly has experienced population decreases during the last three decades, and in 2000 had a population of 4,433. Piketon grew 28.1 percent between 1970 and 1980, but its population remained stable between 1980 and 1990 and increased between 1990 and 2000 and is now 1,907. Pike County's population is expected to continue to grow over the next decade at a rate comparable to the 1980-1990 rate but then slow during the following decade to a growth rate of less than 1 percent (Ohio Data Users Center, 1991).

The 2000 population within 5 miles of the PORTS centerpoint is approximately 5,140 (see Figure 2.1-7 and Table 2.1-1). The geographic distribution of this population is shown in a radial-sector map in Figure 2.1-7, which represents an aggregation into 22.5-degree sectors, with each sector centered on 1 of the 16 compass points. The sectors are divided at radii of 1, 2, 3, 4, and 5 miles.

Historic and projected population density within a 5-mile radius of PORTS are presented in Table 2.1-1.

#### **2.1.3.3 Significant Transient and Special Populations**

In addition to the residential population, there are institutional, transient, and seasonal populations in the PORTS area.

##### **Schools**

The two school systems in the area are the Pike County Schools and the Scioto County Schools. However, only Pike County has school facilities within 5 miles of the facility: two elementary schools, one high school, and a vocational school. The combined enrollment of these schools for the year 2002 was approximately 1,857. The total school population within 5 miles, including faculty and staff, is 2,089. The proximity of these schools to PORTS and their enrollments are shown in Figure 2.1-8.

Two facilities within 5 miles of PORTS provide day care or schooling for preschool-aged children and after-school care for school-aged children (Ohio Department of Human Services, 1992; Barker, 1993). One facility, licensed to accommodate 320 children, is located in Piketon; the other, licensed to accommodate 70 children, is located near the DOE reservation boundary. A number of these positions are filled by school aged children present only during after-school hours. The locations of these facilities are shown in Figure 2.1-8.

##### **Hospitals and Nursing Homes**

Pike Community Hospital is the hospital closest to PORTS, located approximately 7.5 miles north of the facility on State Highway 104 south of Waverly (Pfeifer, 1993). The facility has 37 licensed beds. No other acute care facilities are located in Pike County (Pfeifer, 1993). The location of Pike Community Hospital is shown in Figure 2.1-8.

Two licensed nursing homes are in Piketon, one to the East of PORTS, and one home for the mentally retarded is in Wakefield; all are located within 5 miles of PORTS. The largest of these facilities is a 201-bed facility in Piketon (Ohio Department of Health, 1991). A total of 332 beds are at the facilities within 5 miles of PORTS. Figure 2.1-8 depicts these facilities and shows the number of beds per facility.

### **Recreation Areas and Recreational Events**

No significant recreational areas are on the PORTS site; recreational activities for employees are held offsite (Gideon, 1993).

Offsite recreational areas include the Brush Creek State Forest, a 0.5 square mile portion of which is within 5 miles southwest of PORTS. Usage of this area is extremely light and is estimated to be 20 persons/year, primarily hunters and mushroom pickers (Gamble, 1993b). The location of Brush Creek State Forest is identified in Figure 2.1-8.

Usage of Lake White State Park (Figure 2.1-8), located approximately 7.5 miles north of PORTS, is occasionally heavy and concentrated on the 107 acres of land closest to the lake. The number of visitors in 1992 was 55,876 (Patrick, 1993); daily average was 153. On Labor Day 1992, 7,000 people visited Lake White State Park. When usage is weighted for heavy summer use (assuming 75 percent of all use, except Labor Day usage, occurs during the summer months of June, July, and August), average daily summertime use of the Park is estimated at 407 people. There are 38 campsites for primitive overnight camping (Ohio Department of National Resources, n.d.).

#### **2.1.4 Uses of Nearby Land and Waters**

Land within 5 miles of PORTS is used primarily for farms, forests, and urban or suburban residences. Figure 2.1-11 shows these land uses. About 25,430 acres of farmland, including cropland, wooded lot, and pasture, lie within 5 miles of PORTS. The cropland is located mostly on or adjacent to the Scioto River flood plain and is farmed extensively, particularly with grain crops. The hillsides and terraces are used for cattle pasture. Both beef and dairy cattle are raised in the PORTS area.

Approximately 24,400 acres of forest lie within 5 miles of PORTS (Kornegay et al., 1991, p.12). This includes some commercial woodlands and a very small portion of Brush Creek State Forest.

A relatively small area of urban land, about 510 acres, is also located within 5 miles of PORTS. This is located primarily in and around Piketon, approximately 3.5 miles north of the centerpoint of PORTS.

All or part of 18 Ohio counties, 5 Kentucky counties, and 1 West Virginia county are within 50 miles of PORTS. Almost 2.5 million acres of farmland are within that area (U.S. Bureau of the Census, 1987). This accounts for about 49 percent of the area within this radius. Approximately 65 percent of the farmland is cropland; the remaining farmland is woodland or range and pasture land or is occupied by farm-related buildings.

A notable portion of the land within 50 miles of PORTS is held in the public trust as forest land or for recreational use. State parks of Ohio and Kentucky occupy over 38,000 acres of land within 50 miles of PORTS (OHDNR, n.d.; Hardy, 1993). The Ohio Department of Natural Resources (OHDNR) also manages approximately 165,000 acres of land as state forests, natural preserves, and wildlife areas (OHDNR, 1992). Wayne National Forest occupies approximately 120,000 acres of land within 50 miles of PORTS (R. Jones 1993).

Very few urban areas are located within 50 miles of PORTS. The cities of Chillicothe, Ohio (2000 population of 21,796), and Portsmouth, Ohio (2000 population of 20,909), lie approximately 25 miles away, and the metropolitan area comprising primarily Huntington, West Virginia (pop. 51,475), and Ashland, Kentucky (pop. 21,981), lies approximately 50 miles southeast of PORTS.

No known public or private water supply draws from the Scioto River downstream of PORTS discharge (Kornegay et al., 1991, p. vii).

**Table 2.1-1. Historic and projected population density  
within 5 miles of PORTS (person/mi<sup>2</sup>)**

Year	Persons per square mile
1990	86.3
2000	65.4
2010	104.4
2020	114.5
2030	125.9

ORNL-DWG 87M-67-3R

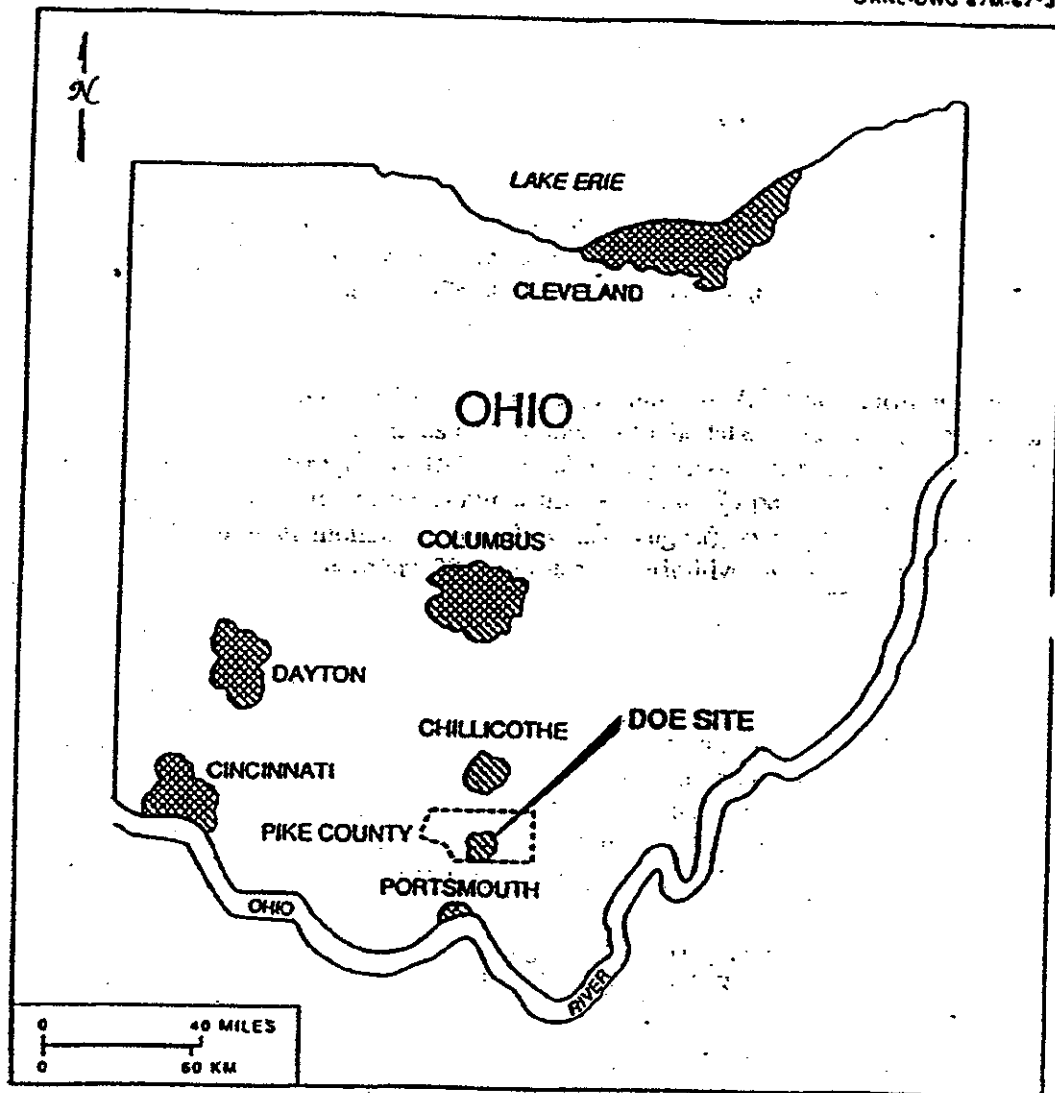


Figure 2.1-1. The location of PORTS.

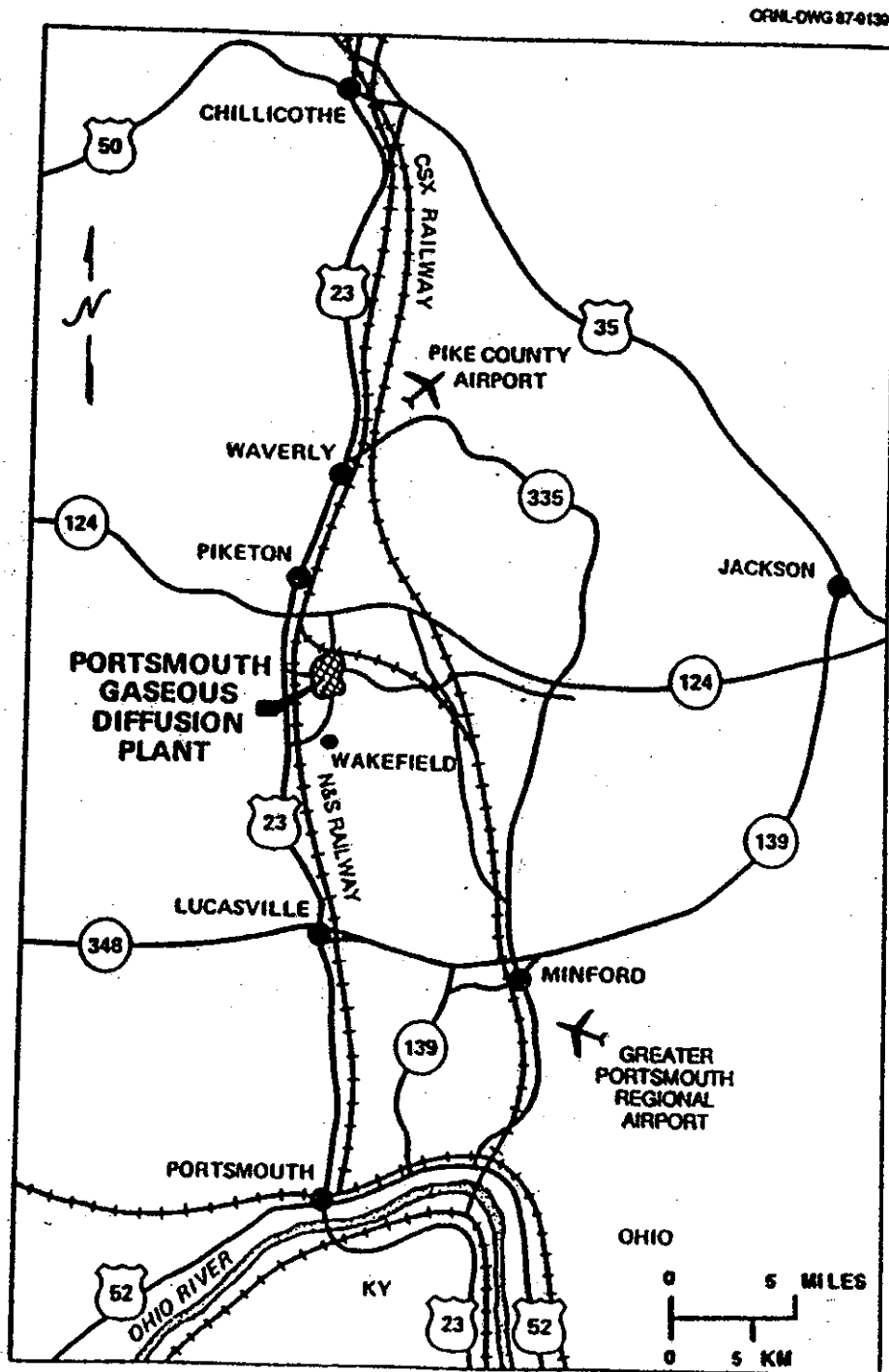


Figure 2.1-2. PORTS and the surrounding region.

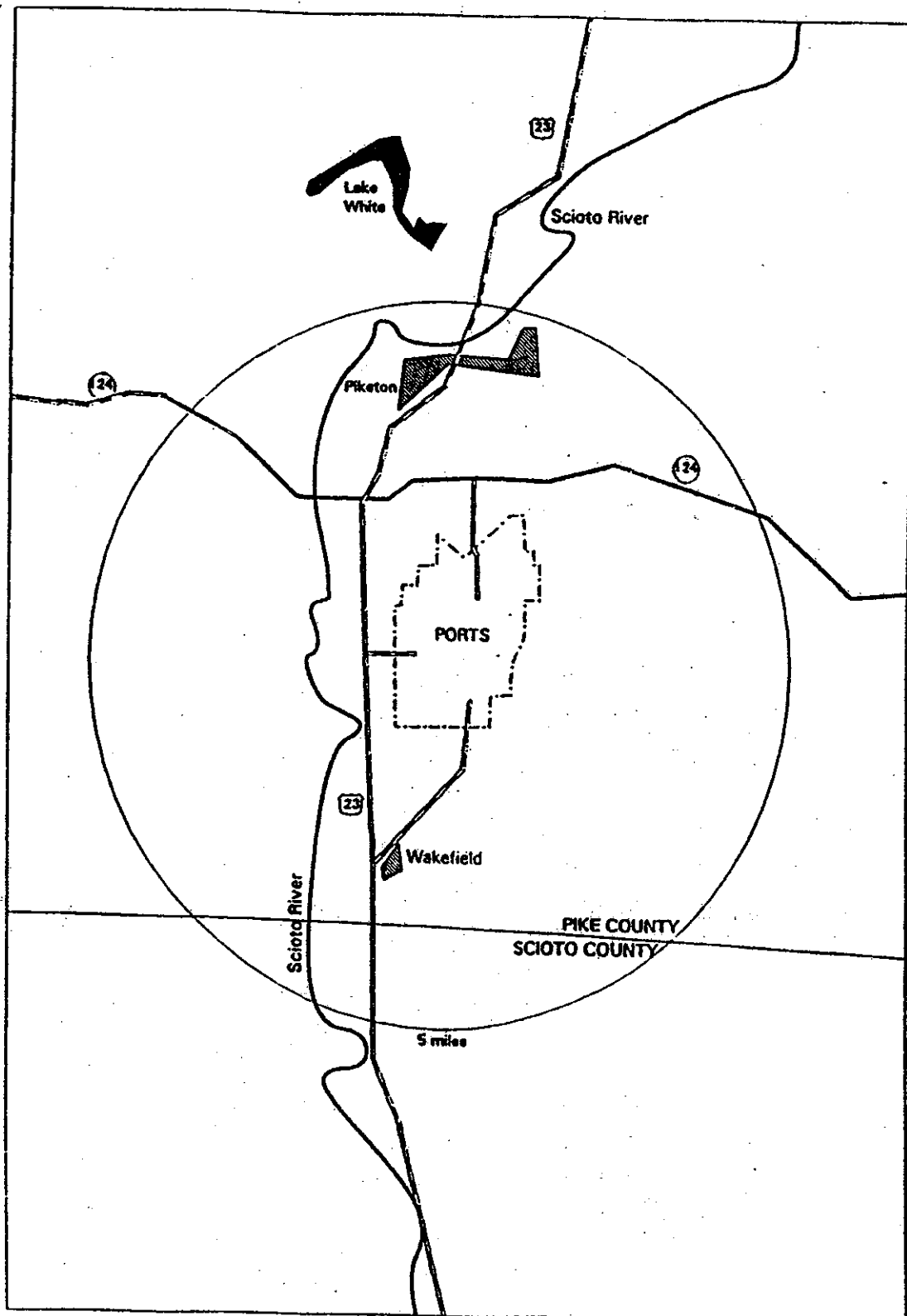
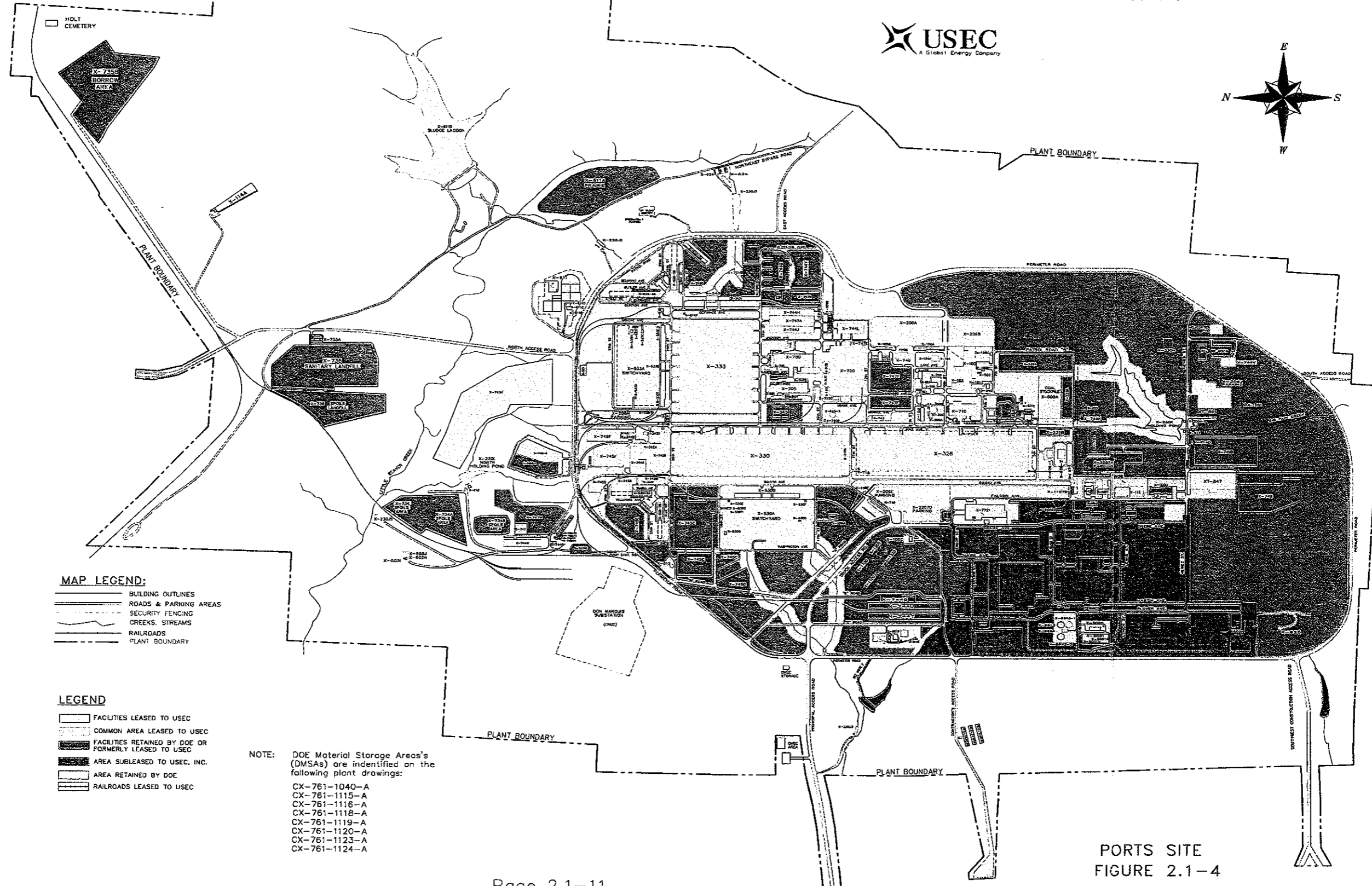
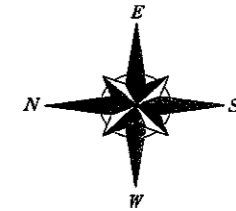


Figure 2.1-3. DOE property boundary, nearby communities, roads, and bodies of water.

# PORTSMOUTH GASEOUS DIFFUSION PLANT

April 15, 2008



PORTS SITE  
FIGURE 2.1-4

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Facility Number	Facility Description	Facility Number	Facility Description
X-100	Administration Building	X-605	Sanitary Water Control House
X-100B	Air Conditioning Equipment Building	X-605A	Sanitary Water Wells
		X-605H	Booster Pump House and Appurtenances
X-101	Health Services	X-605I	Chlorinator Building
X-102	Cafeteria	X-605J	Diesel Generator Building
X-103	Aux. Office Building	X-608	Raw Water Pump House
X-104	Guard Headquarters	X-608A	Raw Water Wells (1 to 4)
X-104A	Indoor Firing Range	X-608B	Raw Water Wells (5 to 15)
X-106	Tactical Response Building	X-611	Water Treatment Plant and Appurtenances
		X-611B	Sludge Lagoon
X-106C	New Fire Training Building	X-611C	Filter Building
X-108A	South Portal and Shelter	X-611D	Recarbonization Instrument Building
X-108B	North Portal and Shelter	X-611E	Clearwell & Chlorine Building
X-108E	Construction Portal	X-612	Elevated Water Tank
X-108H	Pike Avenue Portal	X-614A	Sewage Pumping Station
X-109A	Personnel Monitoring Station	X-614B	Sewage Lift Station
X-109B	Personnel Monitoring Station	X-614D	South Sewage Lift Station
X-109C	Personnel Monitoring Station	X-614P	Northeast Sewage Lift Station
X-111A	SNM Monitoring Portal (X-326)	X-617	South PH Control Facility
X-111B	SNM Monitoring Portal (NW X-326)	X-618	North Holding Pond Storage Building
X-112	Data Processing Building (except portion of Room 135)	X-621	Coal Pile Runoff Treatment Facility
X-114A	Outdoor Firing Range		

**Figure 2.1-5a. Facilities leased to USEC at PORTS site (per agreement dated July 1, 1993).**

Note: This list (facilities leased to USEC) excludes certain DOE Material Storage Areas (DMSAs) within selected facilities which have been retained by DOE. See latest Addendum to Supplement to Exhibit A of the Lease Agreement which distinguishes DMSAs for PGDP and PORTS, and PORTS lease drawings CX-LS-1115-A, CX-LS-1116-A, and CX-LS-1118-A, CX-LS-1119-A, CX-LS-1123-A, CX-LS-1124-A, CX-LS-1199-A, and CX-LS-1200-A.

NOTE: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process

Facility Number	Facility Description	Facility Number	Facility Description
X-120H	Meteorological Tower	X-626-1	Recirculating Water Pump House
X-200	Site Prep, Grading, Landscaping	X-626-2	Cooling Tower
X-201	Land and Land Rights	X-630-1	Recirculating Water Pump House
X-202	Roads (Except Northeast By Pass Road (Fog Road) and X-744G Ancillary Access Roads)	X-630-2A	Cooling Tower
X-204	Railroad (partial: see drawing X-204-1.100-C for details)	X-630-2B	Cooling Tower
X-206A	Main Parking Lot (N)	X-633-1	Recirculating Water Pump House
X-206B	Main Parking Lot (S)	X-633-2A	Cooling Tower
X-206E	Construction Parking	X-633-2B	Cooling Tower
X-206H	Pike Avenue Parking Lot	X-633-2C	Cooling Tower
X-206J	South Office Parking Lot	X-633-2D	Cooling Tower
X-208	Security Fence	X-640-1	Firewater Pump House
X-210	Sidewalks	X-640-2	Elevated Water Tank
X-215A	Electrical Distribution to Process Buildings	X-700	Converter Shop and Cleaning Building (Except Weld Shop Area and Locker Rooms)
X-215B	Electrical Distribution to Other Areas	X-700A	Air Conditioning Equipment Building
X-215C	Exterior Lighting	X-700B	Sand Blast Facility and Observation Booth
X-215D	Electric Power Tunnel	X-705	Decontamination Building (Note)
X-220A	Instrumentation Tunnels	X-705D	Heating Booster Pump Building
X-220B1	Process Instrumentation Lines	X-710	Technical Services Building
X-220B2	Carrier Communication Systems	X-710A	Technical Services Gas Manifold Shed
X-220B3	Water Supply Telemetry Lines	X-710B	Explosion Test Facility
X-220C	Superior American Alarm System	X-720	Maintenance & Stores Building (Note: Several office areas and locker rooms, and some former Instrument Shop and Stores areas have been returned to DOE. See lease drawings CX-LS-1226-A and CX-LS-1227-A for details)
X-220D1	General Telephone		
X-220D2	Process Telephone		

Figure 2.1-5a. (Continued)

Note: The oxide conversion area (X-705E) will not be leased. 2.1-14

Facility Number	Facility Description	Facility Number	Facility Description
X-220D3	Emergency Telephone System	X-720B	Radio Base Station Building
X-220E1	Evacuation Public Address System	X-720C	Paint & Oil Storage Building
X-220E2	Process Public Address System	X-721	Radiation Instrument Calibration Facility
X-220E3	Power Public Address System	X-741	Oil Drum Storage Facility
X-220F	Plant Radio System	X-742	Gas Cylinder Storage Facility
X-220G	Pneumatic Dispatch System	X-743	Lumber Storage Shed
X-220H	MuCulloh Alarm System	X-744B	Salt Storage Building
X-220J	Radiation Alarm System	X-744H	Bulk Storage Building
X-220K	Cascade Automatic Data Processing System	X-744J	Bulk Storage Building
X-220L	Cascade Automatic Data Processing System	X-744L	Stores and Maintenance
		X-744V	Surplus and Salvage Clean Storage Yard
X-220N	Security Alarm and Surveillance System	X-744W	Surplus and Salvage Warehouse
X-220P	Maintenance Work Authorization and Control System	X-745B	Cylinder Storage Yard
X-220R	Public Warning Siren System	X-745D	Cylinder Storage Yard
X-220S	Power Operations SCADA System		
X-230	Water Supply Line	X-745F	North Process Gas Stockpile Yard
X-230A	Sanitary and Fire Water Distribution System	X-745G-2	Cylinder Storage Yard
		X-745H	DU Storage Yard (Note)

**Figure 2.1-5a. (Continued)**

Note: This area (approximately 5 acres) has been identified as a potential site for DU cylinder storage for USEC.

Facility Number	Facility Description	Facility Number	Facility Description
		X-747A	Material Storage Yard
		X-747B	Material Storage Yard
		X-747C	Material Storage Yard
		X-747D	Material Storage Yard
X-230B	Sanitary Sewers		
X-230C	Storm Water Sewers		
X-230D	Softened Water Distribution System		
X-230E	Plant Water System (Makeup to Cooling Towers)		
X-230F	Raw Water Supply Lines		

**Figure 2.1-5a. (Continued)**

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Facility Number	Facility Description	Facility Number	Facility Description
X-230G	RCW System	X-747E	Material Storage Yard
X-230H	Fire Water Distribution System		
X-230J2	South Holding Pond Effluent Monitoring Station	X-748	Truck Scale Facility
X-230J3	West Environmental Monitoring Building	X-750	Mobile Equipment Maintenance Shop
		X-750A	Garage Storage Building
X-230J5	West Environmental Sampling Building	X-760	Chemical Engineering Building
		XT-801	South Office Building
X-230J6	Northeast Monitoring Facility	XT-847	Waste Management Staging Facility
X-230J7	East Monitoring Facility (Note)	X-1007	Fire Station
		X-1020	Emergency Operations Center (EOC) (except Rooms 122, 122A, B, C, 123, 124)
X-230J9	North Environmental Sampling Station		
X-230K	South Holding Pond		
X-230L	North Holding Pond		
X-232A	Nitrogen Distribution System		
X-232B	Dry Air Distribution System		
X-232C1	Tie Line No. 1 X-342 to X-330	X-2202	Roads (GCEP) (from X-1107BV to XT-847)
X-232C2	Tie Line No. 2 X-330 to X-326	X-2204	GCEP Railroads
X-232C3	Tie Line No. 3 X-330 to X-333	X-2207A	GCEP Administrative Parking Lot
X-232C4	Tie Line No. 4 X-326 to X-370	X-2207D	Parking Lot
X-232C5	Tie Line No. 5 X-343 to X-333	X-2208	Security Fence (only the portion that forms the shared boundary between the ACP CAA and the GDP CAA).
X-232D	Steam and Condensate System		
X-232E	Freon Distribution Lines		

Figure 2.1-5a. (Continued)

Note: If a RCRA closure is required in the future, DOE will be responsible for the RCRA closure. USEC will continue to be responsible for maintenance on the NPDES aspect of the facility. Discharge responsibilities after closure depend on who discharges.

Facility Number	Facility Description	Facility Number	Facility Description
X-232F	Fluorine Distribution System		
X-232G	Supports For Distribution Lines	X-2215A	Underground Electrical Distribution to Process Buildings
X-240A	RCW System (Cathodic Protection)	X-2215B	Electrical Distribution to Areas Other Than Process Buildings
X-300	Plant Control Facility	X-2215C	Exterior Light Fixtures
X-300A	Process Monitoring Building	X-2220C	Fire and Supervisory Alarm System
X-300B	Plant Control Facility Carport	X-2220D	Telephone System
X-300C	Emergency Antenna	X-2220L	Classified Computer System
X-326	Process Building (Note)		
X-330	Process Building	X-2230A	Sanitary Water Distribution System
X-333	Process Building	X-2230B	GCEP Sanitary Sewers
		X-2230C	Storm Sewers
X-342A	Feed, Vaporization Fluorine Generation Building	X-2230F	Raw Water Supply Line
X-342B	Fluorine Storage Building		
		X-2230H	Fire Water Distribution System
X-343	Feed, Vaporization and Sampling Facility		
X-344A	UF6 Sampling Facility	X-2230T1	Recirculation Heating Water System
X-344B	Maintenance Storage Building		
X-501	Substation		
X-501A	Substation		
X-502	Substation		
X-515	330 KV Tie Line		

Figure 2.1-5a (Continued)

Note: Several areas designated to contain RCRA Waste in X-326 (2 of which are caged) and the glove box room area adjacent to East L-caged area are not leased.

NOTE: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process

Facility Number	Facility Description	Facility Number	Facility Description
X-530A	Switch Yard	X-3002	Process Building (Transfer Corridor only)
X-530B	Switch House	X-5000	GCEP Switch House
X-530C	Test & Repair Facility	X-5001	Substation
X-530D	Oil House	X-5001A	Valve House
X-530E	Valve House	X-5001B	Oil Pumping Station
X-530F	Valve House	X-5015	HV Electrical System
X-530G	GCEP Oil Pumping Station		
X-533	Transformer Storage Pad		
X-533A	Switch Yard		
X-533B	Switch House	X-6609	Raw Water Wells
X-533C	Test & Repair Facility	X-6613	Sanitary Water Storage Tank
X-533D	Oil House	X-6614E	Sewage Lift Station
X-533E	Valve House	X-6614G	Sewage Lift Station
X-533F	Valve House	X-6614H	Sewage Lift Station
X-533H	Gas Reclaiming Cart Garage	X-6614J	Sewage Lift Station
X-540	Telephone Building	X-6619	Sewage Treatment Plant
X-600	Steam Plant	X-6643	Fire Water Storage Tanks #1 & #2
X-600A	Coal Pile Yard	X-6644	Fire Water Pump House
X-600B	Steam Plant Shop	X-7721	Maintenance Stores Training Building (Training) except Rooms 28, 29, 30, 2 <sup>nd</sup> Floor, Building HVAC/Electrical Rooms, Stairwells and Elevator
X-600C	Ash Wash Treatment Building		

Figure 2.1-5a (Continued)

NOTE: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process

Facility Number	Facility Description	Facility Number	Facility Description
		X-744S	Warehouse S - Non UEA
		X-744T	Warehouse T - Non UEA
X-202	Roads (only Northeast By Pass Road (Fog Road) and X-744G Ancillary Access Roads)		
X-204	Railroad (Partial: see drawing X-204-1.100-C for details) and Railroad Overpass	X-744U	Warehouse U - Non UEA
X-208-A	Boundary Fence	X-744Y	Waste Storage Yard
X-208B	SNM Security Fences X-326 and X-345		
X-230A-3	Ambient Air Monitoring Station A-3 (S. Access Rd.)		
X-230A-6	Ambient Air Monitoring Station A-6 (at Power Pole 6 in Piketon)		
X-230A-8	Ambient Air Monitoring Station A-8 (at Power Pole 74 near X-735)		
X-230A-9	Ambient Air Monitoring Station A-9 (at Wakefield-Mound Rd.)		
X-230A-10	Ambient Air Monitoring Station A-10 (at Don Marquis substation)		
X-230A-12	Ambient Air Monitoring Station A-12 (at McCorkle Rd.)		
X-230A-15	Ambient Air Monitoring Station A-15 (at Loop Rd.)		
X-230A-23	Ambient Air Monitoring Station A-23 (at Taylor Hollow & McCorkle Rd.)		
X-230A-24	Ambient Air Monitoring Station A-24 (at Shyville Rd.)		
X-230A-28	Ambient Air Monitoring Station A-28 (at Camp Creek Rd.)		
X-230A-29	Ambient Air Monitoring Station A-29 (at W. Access Rd.)		
X-230A-36	Ambient Air Monitoring Station A-36 (at X-611)		
X-230A-37	Ambient Air Monitoring Station A-37 (at Mount Hope Rd.)		
X-230A-40	Ambient Air Monitoring Station A-40 (at X-100 Penthouse)		
X-230A-41	Ambient Air Monitoring Station A-41 (at Zahn's Corner)		

Figure 2.1-5b. Facilities retained by DOE at PORTS site.

Facility Number	Facility Description	Facility Number	Facility Description
X-230M	Clean Site NE of XT-801	X-745C	West DUF6 Storage Yards
		X-745E	NW DUF6 Storage Yard
		X-745G-1	Cylinder Storage Yard
		X-746	Materials Receiving and Inspection Building
		X-747	Clean Scrap Yard
		X-747F	Miscellaneous Material Storage Yard
X-231A	Southeast Oil Biodegradation Plot	X-747H	Northwest Surplus and Scrap Yard
		X-747H1	Loading Pad
		X-747K	Contaminated Scrap Metal Storage Yard
X-231B	Southwest Oil Biodegradation Plot	X-749	South Contaminated Materials
X-235	South Ground Water Collection System	X-749A	Storage Yard (Capped)
		X-749B	South Classified Burial Yard (Capped)
			Peter Kiewit Landfill (Capped)
X-237	Little Beaver Ground Water Collection System	X-751	Mobile Equipment Maintenance Shop OANG
X-326-A L-Cage	L-Cage and Glove Box Area	X-752	Warehouse
		X-752AT1	Office Trailer
		X-752AT2	Don/Doff Trailer
		X-752AT3	Restroom Trailer
		X-752AT4	Break Room Trailer
		X-752AT5	HP Trailer
		X-752AT6	Sprung Storage Tent
X-334	Transformer Cleaning Building	X-1000	Administration Building
		X-1107-B(V)	Interplant Vehicle Portal
		X-2200	Site Preparation, Grading and Landscaping
X-345	SNM Storage Building		

Figure 2.1-5b. (Continued)

NOTE: Status of implementation/plant modification associated with RACs identified on this page  
can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process.

Facility Number	Facility Description	Facility Number	Facility Description
X-611A	Prairie	X-2210	Sidewalks
X-622	South Ground Water Treatment Building	<del>X-2230-T2</del>	<del>Recirculating Heating Water System</del>
		X-2232-E	Natural Gas Pipeline

Figure 2.1-5b. (Continued)

NOTE: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process.

Facility Number	Facility Description	Facility Number	Facility Description
X-623	North Ground Water Treatment Building	X-3002	Process Building (except transfer corridor) and South Half)
X-623T1	Office Trailer		
X-624	Little Beaver Ground Water Treatment Facility		
X-624-1	Little Beaver Groundwater Treatment Facility		
X-625	Pilot Scale Treatment Facility	X-6002	Boiler System (NE Corner X-3002 Facility)
X-700	Converter Shop and Cleaning Building (only Weld Shop Area and Locker Rooms)		
X-627	Groundwater Treatment Facility		
X-701B	Holding Pond (Drained)	X-6002A	Oil Storage Facility
X-701E	Neutralization Building		
X-705A	Incinerator		
X-705B	Contaminated Burnable Storage Facility		
X-705E	Oxide Conversion Area		
X-734	Old Sanitary Landfill		
X-734A	Construction Spoils Disposal Area		
X-734B	Construction Spoils Disposal Area		
X-735	Sanitary Landfill	Z-SWMU-QUAD-IV	Southern end of railroad spur which is used as drum storage area
X-735A	Landfill Utility Building	Z-SWMU-QUAD-IV	Chemical and petroleum containment tanks east of X-533C
X-735B	Borrow Area		
X-736	West Construction Spoils Landfill	Z-SWMU-X701	Northeast oil biodegradation plot area, which was formerly used for the disposal of X-615 sludge
X-738	Phytoremediation Groundwater Areas		

Figure 2.1-5b (Continued)

Facility Number	Facility Description	Facility Number	Facility Description
		Z-SWMU-X710	Inactive "hot pit" in the area of X-710 that was once used for the storage of radioactive wastewater
X-744G	Bulk Storage Building		
X-744K	Warehouse K		
X-744N	Warehouse N - Non UEA	Z-SWMU-X744	Retrievable waste storage area
X-744P	Warehouse P - Non UEA	Z-SWMU-XXXX	Solid Waste Management Units, as identified on Portsmouth Environmental Information Management System Drawing, printed 2/9/93.
X-744Q	Warehouse Q - Non UEA		
		X-120 Area	About 5 acres located south of X-2207F, bounded on the west and south by railroad and on the east by a line drawn south from the west end of X-2207F Parking Lot to the railroad and adjacent to Perimeter Road/Railroad

- a) Use of facility includes area necessary for ingress, egress, and proper maintenance of facility.
- b) All existing and future DOE monitoring wells, piezometers, extraction wells, and borings (temporary or permanent) used for the purposes of collecting water level measurements and/or samples for physical and/or chemical analyses are the property of DOE and shall be considered nonleased facilities. The nonleased facility associated with each monitoring well, etc., will include all land within 10 feet of the well, etc. DOE/USEC and their subcontractors shall be allowed ingress to and egress from each well, piezometer, or boring location as necessary. Activities conducted in these locations, including ingress and egress, will be managed in accordance with applicable DOE requirements.
- c) All existing SWMUs/AOCs are the property of DOE. DOE/USEC and their subcontractors shall be allowed ingress to and egress from each SWMU/AOC as necessary, including those that are operating.

Figure 2.1-5b (Continued)

**Figure 2.1-5c. Figure Deleted**

**Figure 2.1-5d. Figure Deleted**

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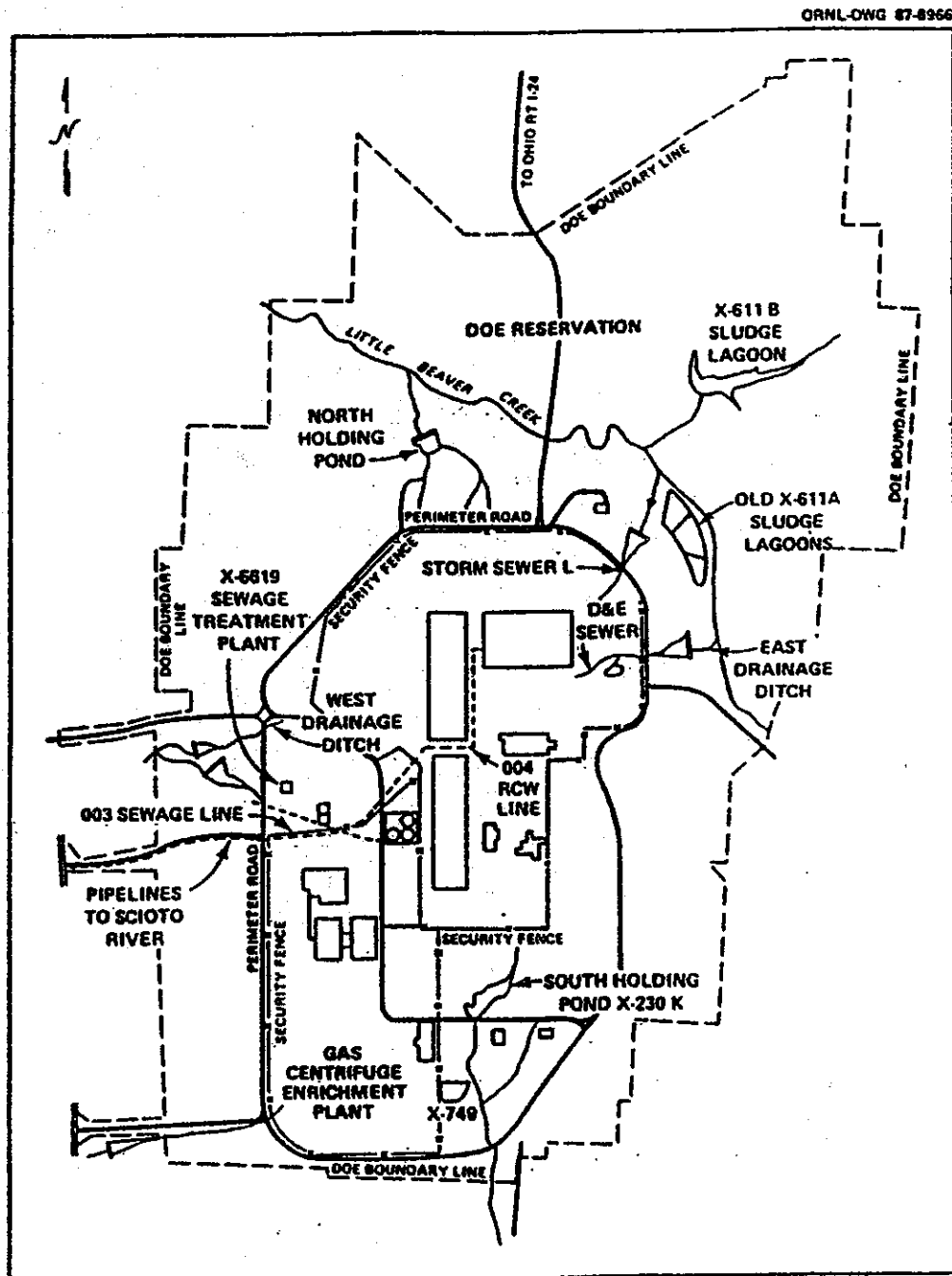


Figure 2.1-6. Major wastewater systems and sources at PORTS.

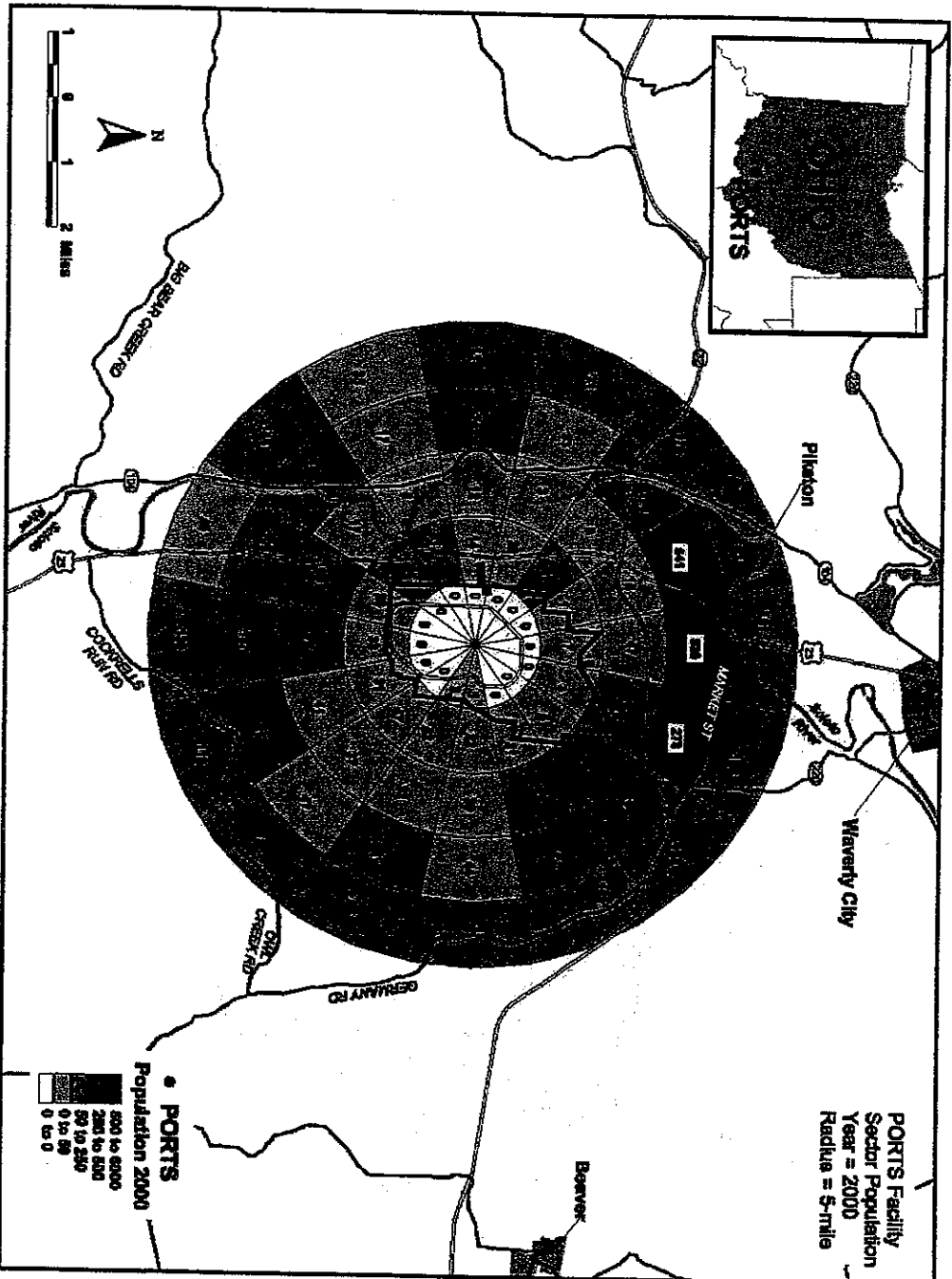


Figure 2.1-7  
Population within 5-Mile Radius of PORTS

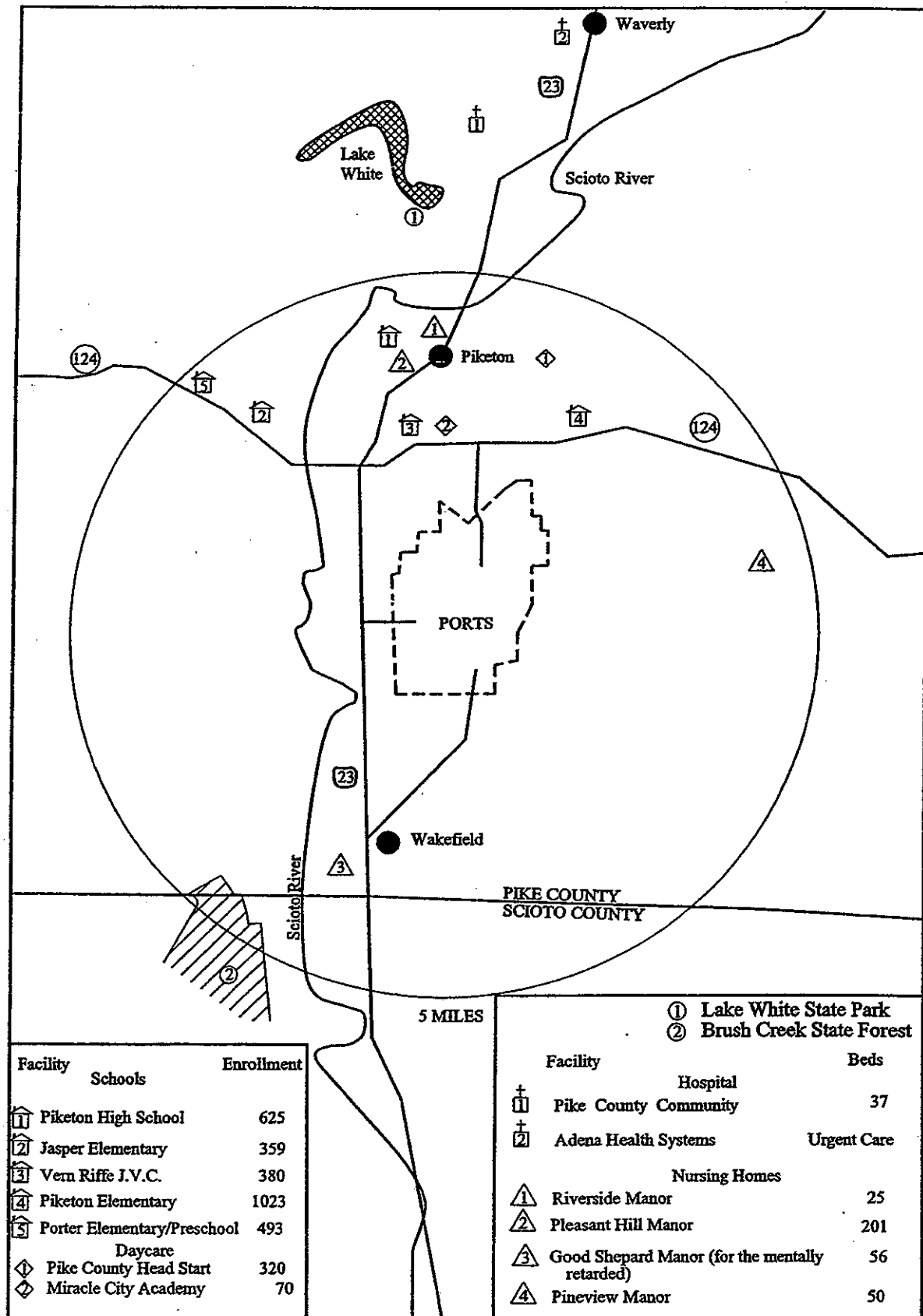


Figure 2.1-8 Special Population Centers within 5 miles of PORTS.

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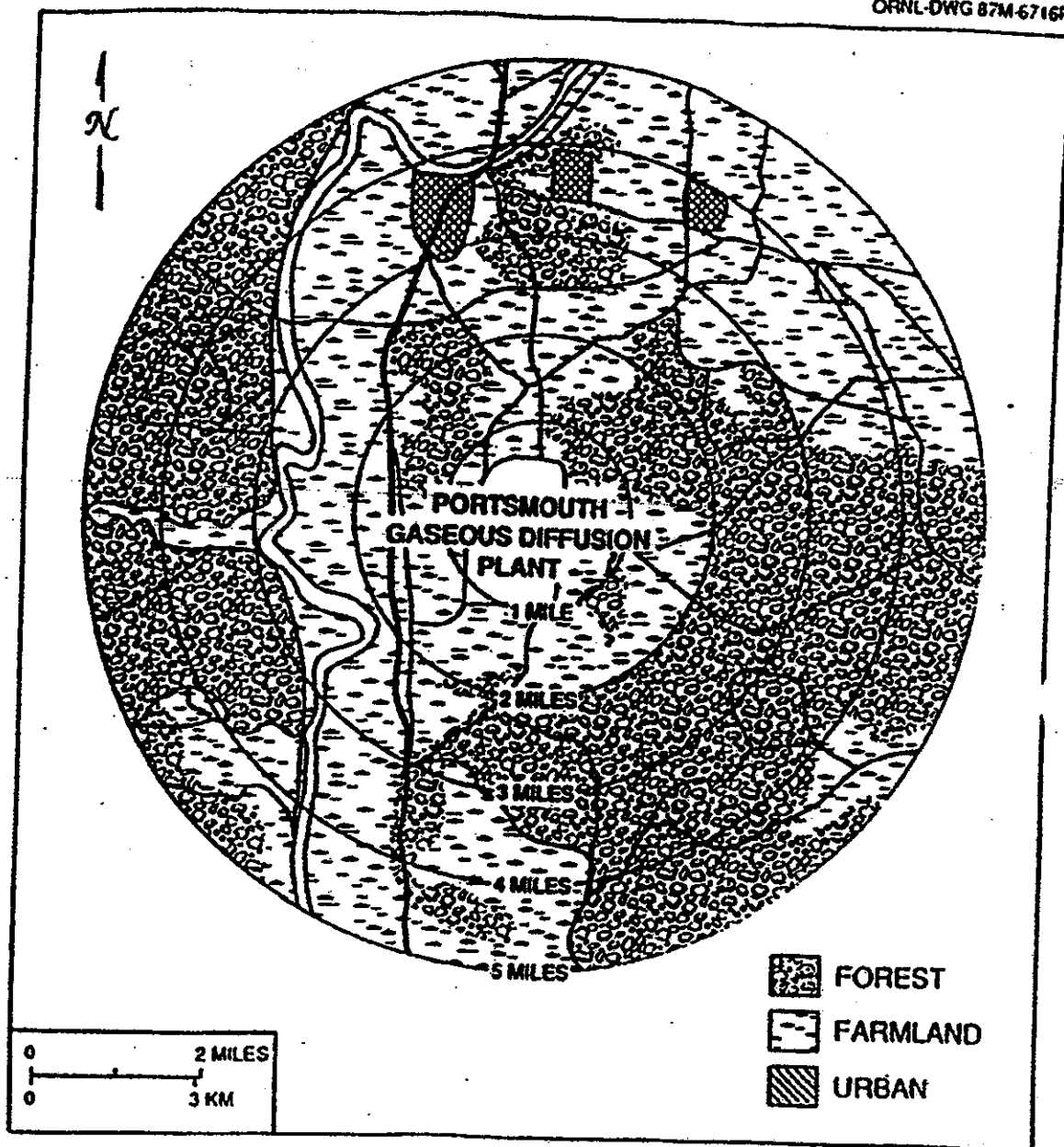


Figure 2.1-11. Land uses within 5 miles of PORTS.

## **2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY ACTIVITIES**

### **2.2.1 Industrial Facilities**

Economic activity in the vicinity near PORTS consists primarily of farming, lumbering, and small businesses. In addition, a gravel quarry is located west of PORTS, adjacent to the Scioto River. The quarrying is done by surface extraction; no explosives are used.

The only significant industry in the vicinity is located in an industrial park south of Waverly (see Figure 2.1-2). The industries include a cabinet manufacturer (2,000 employees) and an automotive parts manufacturer (200 employees). It is not expected that these activities would have any impact on PORTS operations.

### **2.2.2 Transportation Systems and Routes**

Transportation routes and systems are depicted in Figure 2.1-2. The primary roadways near PORTS are U.S. Highway 23 and State Highway 335, which traverse a roughly north-south course, and State Highway 124 (same as State Highway 32), which traverses an east-west course just north of PORTS.

Rail transportation in the area is provided by the N&S Railway and the CSX Railway.

The Pike County Airport is located approximately 11 miles north-northeast of PORTS. No commercial flights or cargo shipping occurs there. The 4,900-ft runway supports single and twin engine planes and small jets. The Greater Portsmouth Regional Airport, located approximately 15 miles southeast of PORTS, provides only light plane service (Class I airport). The nearest commercial airports are Port Columbus International Airport in Columbus, Ohio, approximately 70 miles away, and the airport at Huntington, West Virginia (87 miles away).

### **2.2.3 Military Activities**

The Ohio National Guard maintains an area on the Portsmouth site for the reconditioning and storage of equipment. This equipment primarily consists of mobile equipment that contains no armament; no ordnance is permitted at this location. The maintenance and reconditioning of this equipment is accomplished in and around the X-751 facility, located on the south end of the site.

Although PORTS once maintained a landing strip for air transportation, the strip is now obstructed with earthen berms. The southern end of the landing strip is maintained as a helicopter pad. The Plant Shift Superintendent coordinates helicopter approaches to ensure they do not fly over process buildings or hazardous material storage areas.

Note: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process

## 2.2.4 DOE Activities

In addition to administrating the lease agreement with USEC, DOE conducts various operations on the reservation including environmental restoration, decontamination and decommissioning (D&D), remedial activities [Resource Conservation and Recovery Act (RCRA)]; waste management, treatment, storage, and shipment of low-level radioactive waste (LLRW) and mixed waste; manages DOE non-leased facilities; and is responsible for regulating highly enriched uranium. DOE manages uranium inventories located in site cylinder yards, including cylinders from East Tennessee Technology Park (ETTP), until  $UF_6$  conversion for disposal is accomplished. The  $DUF_6$  conversion plant is under construction with utilities (sanitary water, sewage, High Pressure Fire Water, and electrical power) provided by USEC GDP systems.

As part of DOE GCEP Lease required to make GCEP facilities available for the Lead Cascade centrifuge project and the American Centrifuge Plant, USEC has leased all or portions of GCEP facilities.

In addition, USEC has subleased certain GCEP areas to USEC, Inc. for Lead Cascade operation under the NRC License (See Section 2.2.6) and for preparation for development of the ACP.

Due to the USEC decision to discontinue uranium enrichment at PORTS, it is necessary to provide an alternative heat source for DOE facilities that had been heated by the Recirculating Heating Water (RHW) System. The DOE alternative heating system (RHW Boiler System) consists of two hot work boilers, pumps, controls, and associated equipment in the northeast corner of the X-3002 GCEP Process Building. A natural gas pipeline is installed from the Pike Natural Gas Company pipeline near the East Access road and buried about four feet underground to supply fuel for the boilers. The natural gas pipeline is reduced in pressure to 100 psig when entering the PORTS site and is reduced east of X-622 to 30-40 psig. No. 2 fuel oil is used as a backup fuel supply. The Fuel Oil Storage Area is located approximately 250 feet east of the boilers and consists of three 40,000 gallons fuel oil tanks and a concrete containment dike surrounding and separating these tanks. The original pipeline is tapped just east of Grebe Avenue and a 6" line runs north approximately 600 feet, where a blanked-off tap is installed for future use. At this point the gas line is reduced from 6" to 3" and runs west (under Grebe Avenue) for approximately 200 feet, the line then runs north to the UDS Conversion Facilities.

DOE performed analyses (ASA-SM-3002-0001) for the original installation of the natural gas pipeline, the fuel oil storage, and the X-3002 RHW Boiler System operation. These analyses show that there would be no significant impact from accidents involving explosions or fire at the natural gas pipeline on USEC facilities containing or processing NRC regulated materials. While there could be some minor structural damage and injury to personnel, a fire or explosion would not affect the function of any USEC facilities (with the exception of the X-1107BV vehicle portal which could suffer damage and possible irreversible health consequences to personnel in the portal in the event of an explosion). These analyses were used when evaluating the installation of the additional gas line (north from just east of Grebe Avenue). The installation of the 3" gas line to the UDS Conversion facility is bound by the original analyses. Therefore, there would be no significant impact to any USEC facilities containing or processing NRC regulated materials. There would be minor structural damage and possible ear drum rupture to personnel at the X-1107DV vehicle portal in the event of an explosion. The analyses show that

a fire at the fuel oil storage would not impact any USEC facilities containing or processing NRC regulated materials; a large fire could require evacuation of the USEC X-7721 facility, however, it is unlikely that the facility would be damaged.

DOE has installed emergency shutoff valves at the site boundary to stop gas flow on detection of low pressure/high flow rate condition due to a pipeline rupture (these valves also have overpressure protection). The gas pipeline route is clearly identified to minimize the potential for excavation initiated accidents. The pressure reducing valve (100 psig to 30-40 psig) with a second emergency shutoff valve is installed at least 125 feet east of the X-622 facility.

#### **2.2.5 Section Deleted**

#### **2.2.6 American Centrifuge Lead Cascade Facility**

The American Centrifuge Lead Cascade Facility located in south west quadrant of the PORTS site is comprised of several subleased site facilities. The Lead Cascade will operate up to 240 full scale centrifuge machines arranged in a cascade configuration for the purpose of demonstrating new technology. The cascade will be operated in a "recycle mode" or "closed loop," where the enriched product stream is recombined with the depleted stream prior to being refeed to the cascade. The Lead Cascade will be limited to possessing up to 250 kgs of UF<sub>6</sub> and/or 700 grams of <sup>235</sup>U. No enriched material other than laboratory samples will be withdrawn from the Lead Cascade.

#### **2.2.7 American Centrifuge Plant**

USEC Inc. has received a NRC license for the Construction and Operation of the American Centrifuge Plant (ACP). USEC Inc. has subleased a number of facilities in the southwest quadrant of the plant (GCEP area) for the ACP activities. Construction activities are underway.

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## 2.3 METEOROLOGY

This section provides a meteorological description of PORTS and its surrounding area. The purpose is to provide meteorological information necessary to understand the regional weather phenomena of concern for the PORTS operation and to understand the dispersion analyses performed (DOE 1994, p. 25). Meteorological conditions that influence the design and operation of the facility are identified in Section 2.7.

### 2.3.1 Regional Climatology

Located west of the Appalachian Mountains, the region around PORTS has a climate essentially continental in nature, characterized by moderate extremes of heat and cold and wetness and dryness (Ruffner 1985, p. 843). Figure 2.3-1 graphically portrays monthly mean temperatures averaged over the period from 1951 to 1980 (Ruffner 1985, p. 863) at Waverly, Ohio, which is about 8 miles north of PORTS. Daily maximum and minimum temperatures averaged over the period from 1951 to 1980 are also shown in the figure. July is the hottest month, with an average monthly temperature of 74°F, and January is the coldest month with an average temperature of 30°F. The highest and lowest daily temperatures from 1951 to 1980 were 103 and -25°F on July 14, 1954, and February 3, 1951, respectively. For the results presented above, data from Waverly are used because of the availability of published long-term data.

Moisture in the area is predominantly supplied by air moving northward from the Gulf of Mexico (Ruffner 1985, p. 863). Precipitation is abundant from March through August and sparse in October and February (Figure 2.3-2). The average annual precipitation at Waverly, Ohio, for the period from 1951 to 1980 was 40.4 in. (Ruffner 1985, p. 863). The greatest daily rainfall during this period was 3.38 in., occurring on June 26, 1971. Snowfall occurrence varies from year to year, but is common from November through March (see Figure 2.3-3). The average annual snowfall for the area is about 22 in., based on the 1951-1980 data. During that time period, the maximum monthly snowfall was 25.4 in., occurring in January 1978.

Occasionally, heavy amounts of rain associated with thunderstorms or low pressure systems will fall in a short period of time. The U.S. Weather Bureau has published values of the total precipitation for durations from 30 min to 24 h and return periods from 1 to 100 yr (Hershfield 1963). The results for the geographic locale including PORTS are summarized in Table 2.3-1. A local drainage analysis for extreme storms at PORTS has been performed (see Johnson et al. 1993).

The predominant winds at PORTS blow from the south or southwest and at times from the north (ERDA 1977, p. 3-18). The average wind speed is about 5 mph. On the average, from 1953 to 1989, 14 tornadoes per year were reported in Ohio, but the total varies widely from year to year (e.g., 43 in 1973 and 0 in 1988) (Bair 1992, p. 110). Pike County, where PORTS is located, had two tornadoes during the 20-yr period from 1953 to 1972 (Davis 1973).

### 2.3.2 On-Site Meteorological Measurements Program

PORTS maintained a single 131 ft meteorological tower (Building X-120; plant coordinates: E 8500 ft, N 4100 ft located south of XT-801) before 1995. It was equipped with instrument packages at the 33- and 105-ft (10- and 32-m) levels that measure air temperature, relative humidity, and wind speed

and direction (Kornegay et al. 1994, p. 5-10). [Results labeled as 131 or 105 ft (40 or 32 m) in this section were all measured at 105 ft (32 m)]. Prior to 1995, not all the meteorological instrumentation at PORTS might be reliable (Kornegay et al. 1994, p. 5-11). Since January 1995, a new 200-ft (60-m) tower has been in use. It is equipped with instrument packages at the 33, 98, and 200 ft (10, 30, and 60 m) levels. In addition, ground-level instrumentation measures solar radiation, barometric pressure, precipitation, and soil temperatures at 1- and 2-ft depths.

### 2.3.3 Local Meteorology

Hourly temperatures at 33- and 105-ft (10- and 32-m) (labeled as 40-m) levels above the ground were recorded at the PORTS meteorological tower before 1995. The results for 1994 are shown in Figure 2.3-4. At each level, 8555 of the possible 8760 data points are available. The seasonal temperature variation and the daily temperature fluctuations are consistent with the long-term averages shown in Figure 2.3-1 for Waverly, Ohio. The two sets of temperature readings at the PORTS meteorological tower are highly correlated, as one would expect. Since January 1995, temperatures at 33, 98, and 200 ft (10, 30, and 60 m) have been measured at the new tower.

The average annual relative humidities at Lexington (Kentucky), Cincinnati and Columbus (Ohio), and Charleston (West Virginia) are all very close to 70% (Bair 1992, pp. 553, 689, 697, and 821). Relative humidity data is transmitted each hour by the meteorological tower. The average relative humidity based on the meteorological tower data ranges from 70 % - 105% for calendar years 1997 to 2004; the data variability is not consistent with the regional climatological average RH. Site relative humidity is best represented by the regional climatological data summaries. Figure 2.3-5 provides the "Normals, Means, and Extremes" data summary for the Cincinnati regional airport (NOAA location CVG).

Hourly wind speed and wind direction data for 1994 obtained from PORTS (Blythe 1995) are plotted in Figures 2.3-6 and 2.3-7, respectively. Out of 8760 possible hourly data sets, 8430 are available for wind speed and 8423 for wind direction. The average wind speeds were 3.7 and 6.0 mph at 33- and 105-ft (10- and 32-m) levels, respectively. Wind roses at 33 and 105 ft (labeled as 131 ft) [10 and 32 m (labeled as 40 m)] at PORTS constructed from the 1993 data are compared in Figure 2.3-8. Average wind roses constructed from 1992-1994 data are shown in Figures 2.3-9 and 2.3-10 for 33- and 105-ft (10- and 32-m) levels, respectively.

Joint frequency distribution of atmospheric stability, wind direction, and wind speed at 33-ft and 105-ft (10- and 32-m) above ground at PORTS for 1993 were provided by PORTS (Blythe 1994 and 1995). Sigma theta data (standard deviations of the wind direction) were used when available and  $\Delta T/\Delta Z$  values were used otherwise. These distributions are shown in Tables 2.3-2 and 2.3-3.

**Table 2.3-1. Precipitation in inches as a function of recurrence interval and storm duration for the PORTS area**

Recurrence interval (yr)	Storm duration (h)						
	0.5	1	2	3	6	12	24
1	0.85	1.06	1.34	1.44	1.75	2.04	2.43
2	1.04	1.28	1.57	1.71	2.02	2.44	2.70
5	1.36	1.66	1.98	2.14	2.52	2.98	3.41
10	1.52	1.93	2.30	2.52	2.98	3.40	3.90
25	1.76	2.24	2.64	2.92	3.38	3.91	4.55
50	1.96	2.51	2.97	3.16	3.78	4.20	4.93
100	2.16	2.73	3.22	3.48	4.00	4.88	5.26

1 in. = 2.54 cm.

Source: Johnson et al. 1993, p. 4-2.

Table 2.3-2. Joint frequency distribution, in %, of atmospheric stability, wind direction, and wind speed at 10 m above ground at PORTS for 1993

Stability category	Wind direction	Wind speed class (m/s)						Total
		<2	2-4	4-6	6-8	8-10	>10	
A	N	0.86	0.60	0.23	0.02	0	0	1.71
	NNE	0.94	0.56	0.03	0	0	0	1.53
	NE	1.45	0.30	0	0	0	0	1.76
	ENE	1.26	0.24	0	0	0	0	1.50
	E	1.33	0.30	0	0	0	0	1.63
	ESE	1.49	0.36	0	0	0	0	1.86
	SE	1.70	0.28	0	0	0	0	1.98
	SSE	2.43	0.24	0	0	0	0	2.67
	S	3.58	0.66	0	0	0	0	4.25
	SSW	3.23	1.07	0.05	0	0	0	4.35
	SW	3.17	1.41	0.05	0	0	0	4.63
	WSW	2.57	1.57	0.18	0.03	0	0	4.35
	W	1.94	0.74	0.11	0.08	0	0	2.87
	WNW	1.55	0.53	0.08	0	0	0	2.17
	NW	1.25	0.42	0.02	0	0	0	1.69
	NNW	1.27	0.64	0.09	0.02	0	0	2.02
	Total	30.02	9.93	0.86	0.15	0	0	40.96
B	N	0.14	0.29	0.24	0.05	0.03	0	0.75
	NNE	0.21	0.16	0.03	0	0	0	0.41
	NE	0.43	0.15	0	0	0	0	0.58
	ENE	0.58	0.18	0	0	0	0	0.77
	E	0.71	0.27	0.02	0	0	0	1.00
	ESE	0.92	0.49	0.02	0	0	0	1.43
	SE	0.68	0.40	0	0	0	0	1.08
	SSE	0.99	0.47	0.05	0	0	0	1.51
	S	1.83	0.75	0.09	0	0	0	2.67
	SSW	1.71	1.41	0.21	0	0	0	3.34
	SW	0.94	0.79	0.19	0.02	0	0	1.95
	WSW	0.60	0.71	0.16	0.01	0	0	1.48
	W	0.32	0.23	0.04	0	0	0	0.60
	WNW	0.19	0.22	0.02	0	0	0	0.43
	NW	0.22	0.23	0.06	0	0	0	0.51
	NNW	0.32	0.44	0.13	0.02	0	0	0.90
	Total	10.77	7.19	1.27	0.14	0.03	0	19.40

Table 2.3-2 (continued)

Stability category	Wind direction	Wind speed class (m/s)						Total
		<2	2-4	4-6	6-8	8-10	>10	
C	N	0.08	0.06	0.04	0.02	0.03	0	0.24
	NNE	0.19	0.39	0.28	0.10	0	0	0.96
	NE	0.59	0.27	0	0	0	0	0.84
	ENE	0.47	0.20	0.02	0	0	0	0.69
	E	0.83	0.26	0.02	0	0	0	1.11
	ESE	0.78	0.39	0	0	0	0	1.18
	SE	0.42	0.13	0	0	0	0	0.56
	SSE	0.94	0.22	0.04	0.01	0	0	1.21
	S	2.15	0.85	0.18	0.02	0	0	3.20
	SSW	2.01	0.93	0.20	0	0	0	3.14
	SW	0.66	0.29	0.04	0	0	0	0.99
	WSW	0.50	0.59	0.47	0.09	0	0	1.65
	W	0.33	0.81	0.64	0.15	0	0	1.94
	WNW	0.30	1.00	0.22	0.02	0	0	1.54
	NW	0.23	0.66	0.20	0	0	0	1.08
	NNW	0.15	0.25	0.04	0.03	0	0	0.47
	Total	10.63	7.26	2.41	0.44	0.04	0	20.78
D	N	0.02	0	0	0	0	0	0.02
	NNE	0.21	0.27	0.08	0.02	0	0	0.57
	NE	0.40	0.53	0.21	0	0	0	1.14
	ENE	0.29	0.08	0	0	0	0	0.37
	E	0.44	0.08	0	0	0	0	0.52
	ESE	0.35	0.03	0	0	0	0	0.38
	SE	0.20	0	0	0	0	0	0.20
	SSE	0.79	0	0	0	0	0	0.79
	S	1.43	0.04	0.01	0	0	0	1.48
	SSW	0.86	0.03	0	0	0	0	0.90
	SW	0.23	0	0	0	0	0	0.23
	WSW	0.27	0.17	0.06	0.02	0	0	0.52
	W	0.23	0.27	0.10	0.01	0	0	0.60
	WNW	0.17	0.12	0	0	0	0	0.29
	NW	0.10	0.15	0.02	0	0	0	0.26
	NNW	0.02	0.01	0	0	0	0	0.03
	Total	5.99	1.78	0.49	0.05	0	0	8.30

Table 2.3-2 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		<2	2-4	4-6	6-8	8-10	>10	Total
E	N	0	0	0	0	0	0	0
	NNE	0.02	0	0.02	0	0	0	0.04
	NE	0.04	0.03	0	0	0	0	0.07
	ENE	0.02	0	0	0	0	0	0.03
	E	0.08	0	0	0	0	0	0.08
	ESE	0.03	0	0	0	0	0	0.03
	SE	0.04	0	0	0	0	0	0.04
	SSE	0.18	0	0	0	0	0	0.18
	S	0.30	0	0	0	0	0	0.30
	SSW	0.17	0	0	0	0	0	0.17
	SW	0.02	0	0	0	0	0	0.02
	WSW	0.02	0	0	0	0	0	0.02
	W	0.01	0	0	0	0	0	0.02
	WNW	0.03	0	0	0	0	0	0.03
	NW	0	0	0	0	0	0	0
	NNW	0	0	0	0	0	0	0
	Total	0.95	0.05	0.02	0	0	0	1.02
F	N	4.79	0	0	0	0	0	4.79
	NNE	0.11	0	0	0	0	0	0.11
	NE	0.14	0	0	0	0	0	0.14
	ENE	0.21	0	0	0	0	0	0.21
	E	0.40	0	0	0	0	0	0.40
	ESE	0.32	0	0	0	0	0	0.32
	SE	0.47	0	0	0	0	0	0.47
	SSE	0.69	0	0	0	0	0	0.69
	S	0.82	0	0	0	0	0	0.82
	SSW	0.48	0	0	0	0	0	0.48
	SW	0.32	0	0	0	0	0	0.32
	WSW	0.20	0	0	0	0	0	0.20
	W	0.18	0	0	0	0	0	0.18
	WNW	0.16	0	0	0	0	0	0.16
	NW	0.11	0	0	0	0	0	0.11
	NNW	0.14	0	0	0	0	0	0.14
	Total	9.54	0	0	0	0	0	9.54

Table 2.3-2 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		<2	2-4	4-6	6-8	8-10	>10	Total
A L L	N	5.89	0.96	0.51	0.09	0.06	0	7.51
	NNE	1.67	1.38	0.44	0.12	0	0	3.62
	NE	3.04	1.26	0.22	0	0	0	4.52
	ENE	2.83	0.71	0.03	0	0	0	3.56
	E	3.78	0.90	0.05	0	0	0	4.73
	ESE	3.89	1.27	0.03	0	0	0	5.19
	SE	3.50	0.81	0	0	0	0	4.32
	SSE	6.01	0.93	0.09	0.02	0	0	7.06
	S	10.12	2.30	0.28	0.03	0	0	12.73
	SSW	8.46	3.44	0.46	0	0	0	12.37
	SW	5.33	2.49	0.28	0.03	0	0	8.13
	WSW	4.15	3.04	0.88	0.15	0	0	8.22
	W	3.01	2.05	0.90	0.24	0	0	6.20
	WNW	2.41	1.88	0.32	0.03	0	0	4.62
	NW	1.90	1.46	0.30	0	0	0	3.66
	NNW	1.90	1.34	0.25	0.06	0	0	3.56
	Total	67.89	26.21	5.05	0.77	0.08	0	100.00

Table 2.3-3. Joint frequency distribution, in %, of atmospheric stability, wind direction, and wind speed at 32 m above ground at PORTS for 1993

Stability category	Wind direction	Wind speed class (m/s)						
		0-2.1	2.1-3.6	3.6-5.7	5.7-8.7	8.7-10.8	>10.8	Total
A	N	0.83	0.64	0.21	0.10	0	0	1.79
	NNE	0.93	0.70	0.07	0	0	0	1.71
	NE	0.78	0.30	0	0	0	0	1.09
	ENE	0.69	0.25	0.02	0	0	0	0.96
	E	0.65	0.22	0	0	0	0	0.87
	ESE	0.65	0.16	0	0	0	0	0.80
	SE	0.84	0.14	0	0	0	0	0.99
	SSE	1.00	0.15	0	0	0	0	1.16
	S	1.25	0.18	0	0	0	0	1.46
	SSW	1.53	0.33	0.02	0	0	0	1.88
	SW	1.61	0.45	0.05	0	0	0	2.12
	WSW	1.36	0.39	0.07	0.03	.02	0	1.87
	W	1.05	0.37	0.12	0.08	.05	0	1.67
	WNW	0.85	0.30	0.13	0.02	0	0	1.30
	NW	0.71	0.32	0.05	0	0	0	1.08
	NNW	0.71	0.51	0.11	0.01	0	0	1.35
	Total	15.43	5.42	0.88	0.27	.08	0	22.09
B	N	0.12	0.12	0.10	0.04	0	0	0.38
	NNE	0.16	0.13	0.03	0	0	0	0.31
	NE	0.17	0.13	0	0	0	0	0.31
	ENE	0.28	0.22	0.04	0	0	0	0.54
	E	0.26	0.25	0.03	0	0	0	0.54
	ESE	0.23	0.24	0.03	0	0	0	0.51
	SE	0.30	0.17	0.02	0	0	0	0.49
	SSE	0.36	0.14	0.02	0	0	0	0.51
	S	0.54	0.22	0.03	0	0	0	0.80
	SSW	0.60	0.40	0.09	0	0	0	1.09
	SW	0.63	0.45	0.17	0.02	0	0	1.28
	WSW	0.43	0.30	0.09	0.04	0	0	0.88
	W	0.36	0.21	0.07	0.02	0	0	0.66
	WNW	0.24	0.12	0.06	0.01	0	0	0.42
	NW	0.21	0.13	0.06	0.01	0	0	0.42
	NNW	0.12	0.23	0.11	0.04	.02	0.01	0.54
	Total	5.00	3.45	0.97	0.20	.04	0.02	9.68

Table 2.3-3 (continued)

Stability category	Wind direction	Wind speed class (m/s)						Total
		0-2.1	2.1-3.6	3.6-5.7	5.7-8.7	8.7-10.8	>10.8	
C	N	0.09	0.17	0.13	0.11	0.03	0.04	0.56
	NNE	0.15	0.20	0.05	0	0	0	0.41
	NE	0.36	0.27	0.02	0	0	0	0.65
	ENE	0.31	0.41	0.09	0	0	0	0.81
	E	0.30	0.51	0.11	0	0	0	0.92
	ESE	0.26	0.56	0.17	0	0	0	1.00
	SE	0.36	0.49	0.22	0.01	0	0	1.09
	SSE	0.54	0.44	0.15	0.03	0	0	1.16
	S	0.79	0.65	0.41	0.09	0	0	1.94
	SSW	0.89	0.98	0.58	0.21	0	0	2.68
	SW	0.72	0.87	0.85	0.24	0.03	0	2.72
	WSW	0.50	0.55	0.43	0.18	0.04	0	1.71
	W	0.41	0.30	0.23	0.11	0.02	0	1.08
	WNW	0.30	0.29	0.22	0.07	0	0	0.89
	NW	0.14	0.34	0.22	0.06	0.02	0	0.78
	NNW	0.11	0.38	0.22	0.05	0.01	0	0.77
	Total	6.25	7.41	4.11	1.18	0.15	0.06	19.17
D	N	0.07	0.06	0.11	0.07	0.03	0.03	0.36
	NNE	0.29	0.42	0.28	0.09	0.02	0	1.11
	NE	0.38	0.70	0.16	0	0	0	1.25
	ENE	0.33	0.51	0.13	0	0	0	0.97
	E	0.27	0.78	0.16	0.01	0	0	1.22
	ESE	0.32	1.09	0.41	0.05	0	0	1.87
	SE	0.40	0.74	0.30	0.02	0	0	1.47
	SSE	0.84	0.53	0.48	0.18	0.03	0.01	2.08
	S	1.02	1.91	1.13	0.26	0.01	0	4.34
	SSW	0.79	1.70	1.32	0.51	0.08	0	4.42
	SW	0.84	1.27	0.88	0.38	0.06	0	3.43
	WSW	0.71	0.88	0.91	0.56	0.35	0.07	3.48
	W	0.57	0.77	0.83	0.62	0.19	0.08	3.05
	WNW	0.36	0.74	0.88	0.33	0.05	0	2.35
	NW	0.11	0.59	0.38	0.15	0.02	0	1.24
	NNW	0.03	0.27	0.03	0	0	0	0.32
	Total	7.33	12.96	8.38	3.23	.85	.22	32.97

Table 2.3-3 (continued)

Stability category	Wind direction	Wind speed class (m/s)						Total
		0-2.1	2.1-3.6	3.6-5.7	5.7-8.7	8.7-10.8	>10.8	
E	N	0	0	0	0.01	0	0	0.05
	NNE	0.18	0.69	0.35	0.17	0.07	0	1.47
	NE	0.19	0.60	0.35	0.10	0	0	1.23
	ENE	0.13	0.34	0.04	0	0	0	0.50
	E	0.19	0.28	0	0	0	0	0.47
	ESE	0.11	0.34	0.04	0	0	0	0.50
	SE	0.22	0.16	0	0	0	0	0.38
	SSE	0.51	0.20	0.03	0.03	0	0	0.76
	S	0.58	0.69	0.10	0	0	0	1.37
	SSW	0.36	0.89	0.32	0	0	0	1.56
	SW	0.37	0.42	0.04	0	0	0	0.83
	WSW	0.54	0.31	0.11	0.03	0	0	0.99
	W	0.22	0.27	0.07	0.03	0	0	0.59
	WNW	0.19	0.45	0.14	0.05	0	0	0.84
	NW	0.05	0.19	0.08	0.02	0	0	0.34
	NNW	0	0.03	0	0	0	0	0.04
	Total	3.85	5.87	1.69	.42	.08	0	11.93
F	N	0.39	0	0	0	0	0	0.39
	NNE	0.12	0.12	0.06	.01	0	0	0.31
	NE	0.11	0.13	0.03	0	0	0	0.28
	ENE	0.11	0.02	0	0	0	0	0.13
	E	0.22	0.03	0	0	0	0	0.24
	ESE	0.12	0	0	0	0	0	0.12
	SE	0.19	0.02	0	0	0	0	0.21
	SSE	0.28	0.02	0	0	0	0	0.30
	S	0.30	0.10	0	0	0	0	0.41
	SSW	0.27	0.07	0	0	0	0	0.35
	SW	0.24	0.02	0	0	0	0	0.25
	WSW	0.43	0.03	0	0	0	0	0.46
	W	0.30	0	0	0	0	0	0.31
	WNW	0.17	0.02	0	0	0	0	0.19
	NW	0.12	0.02	0.01	0	0	0	0.15
	NNW	0.07	0	0	0	0	0	0.07
	Total	3.43	.60	.13	.01	0	0	4.17

Table 2.3-3 (continued)

Stability category	Wind direction	Wind speed class (m/s)						Total
		0-2.1	2.1-3.6	3.6-5.7	5.7-8.7	8.7-10.8	>10.8	
A L L	N	1.50	1.00	0.57	0.33	0.06	0.07	3.52
	NNE	1.83	2.26	0.85	0.28	0.09	0	5.32
	NE	1.99	2.15	0.57	0.10	0	0	4.81
	ENE	1.84	1.74	0.32	0.01	0	0	3.91
	E	1.89	2.05	0.31	0.01	0	0	4.27
	ESE	1.69	2.39	0.66	0.06	0	0	4.80
	SE	2.32	1.72	0.55	0.03	0	0	4.63
	SSE	3.52	1.49	0.68	0.23	0.03	0.02	5.98
	S	4.48	3.75	1.69	0.36	0.02	0	10.31
	SSW	4.44	4.37	2.34	0.73	0.09	0	11.97
	SW	4.40	3.48	1.98	0.66	0.09	0.01	10.62
	WSW	3.98	2.45	1.61	0.83	0.42	0.08	9.38
	W	2.90	1.93	1.32	0.85	0.27	0.09	7.36
	WNW	2.11	1.91	1.44	0.48	0.06	0	6.00
	NW	1.35	1.59	0.80	0.24	0.03	0	4.01
	NNW	1.06	1.42	0.47	0.10	0.04	0.02	3.10
	Total	41.29	35.72	16.16	5.32	1.21	.31	100.00

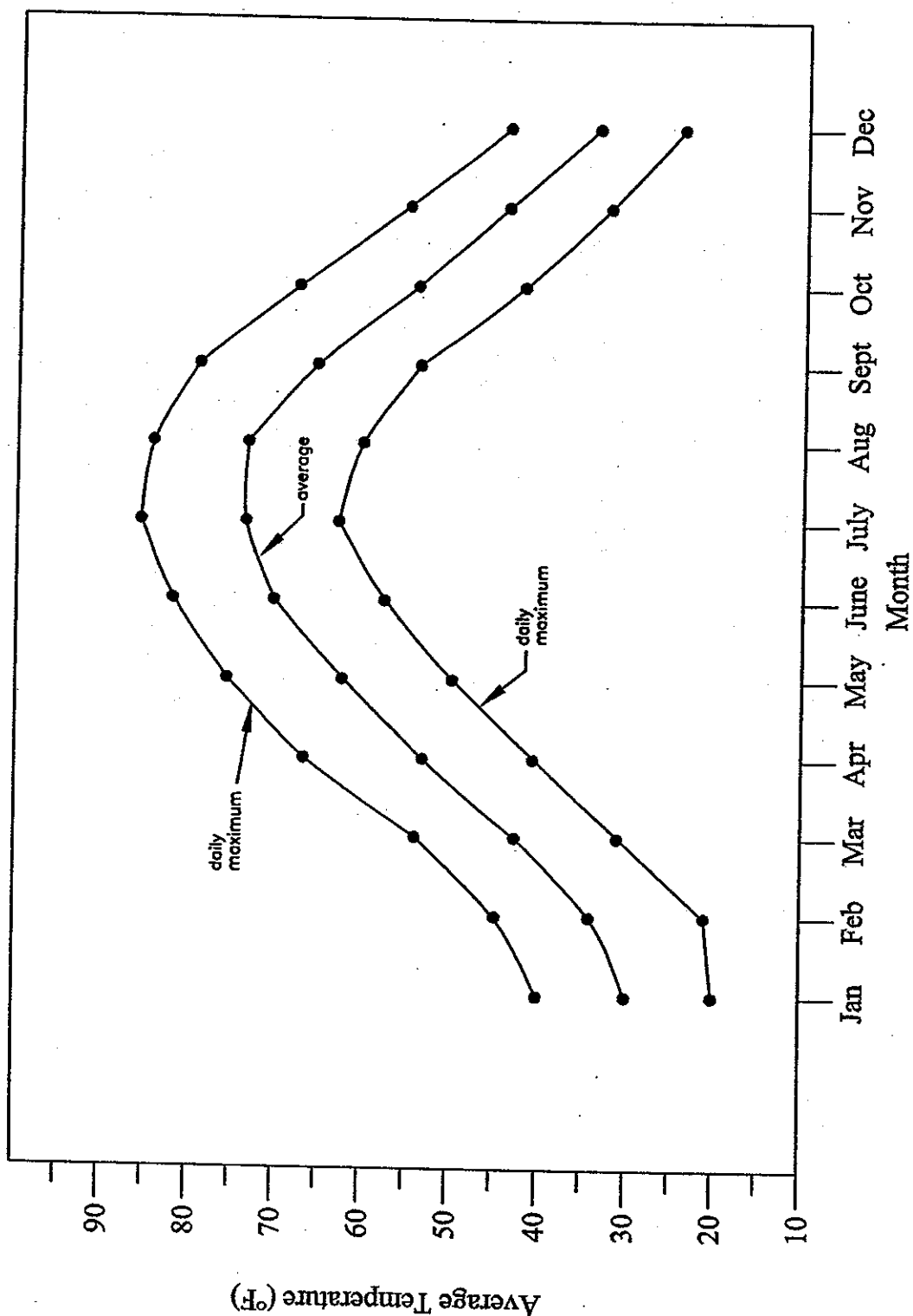


Figure 2.3-1 Monthly mean temperatures averaged over the period from 1951 to 1980 at Waverly, Ohio (Data Source: p. 863, Ruffner 1985)

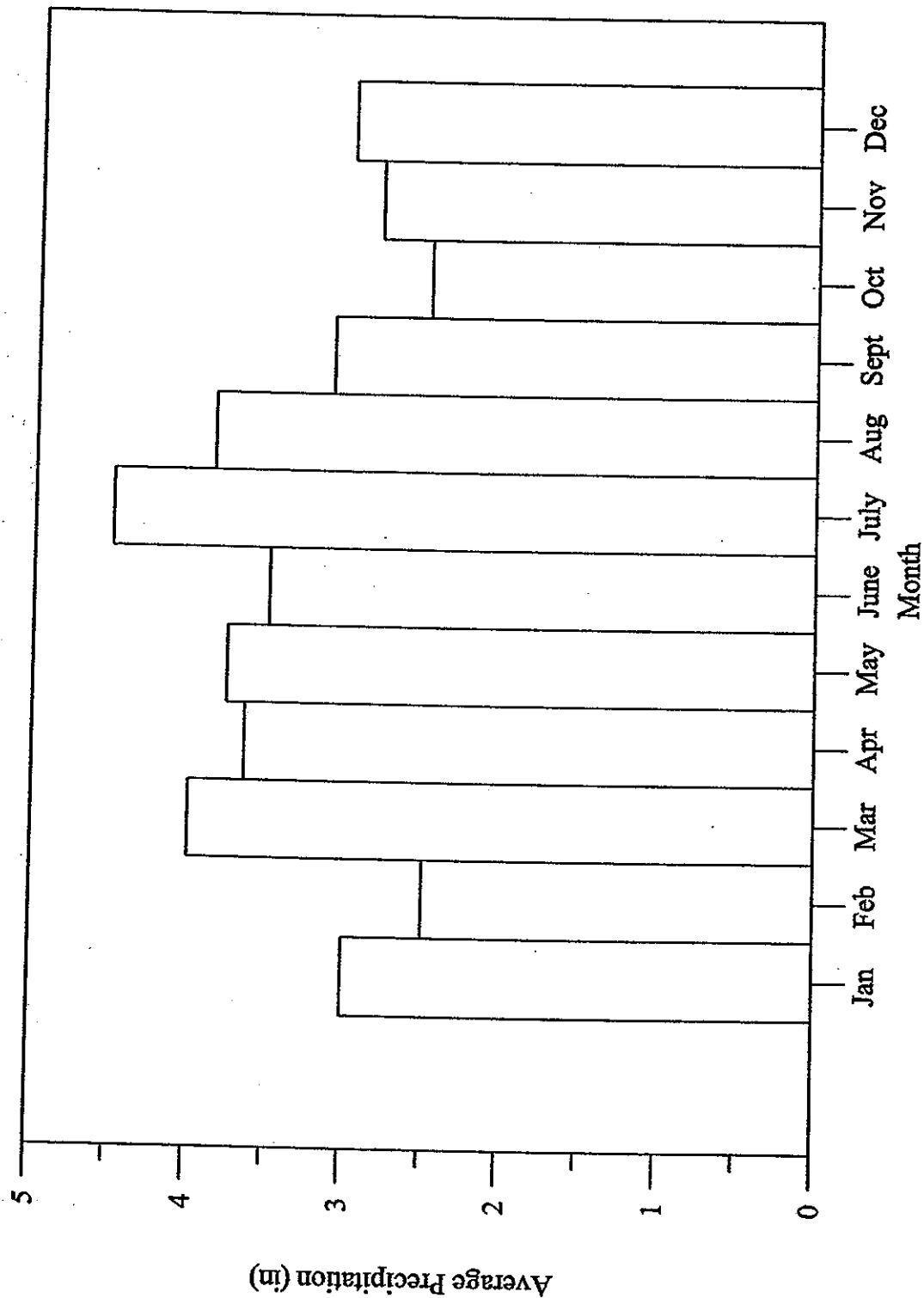


Figure 2.3-2 Monthly mean precipitation averaged over the period from 1951 to 1980 at Waverly, Ohio (Data Source: p. 863, Ruffner 1985)

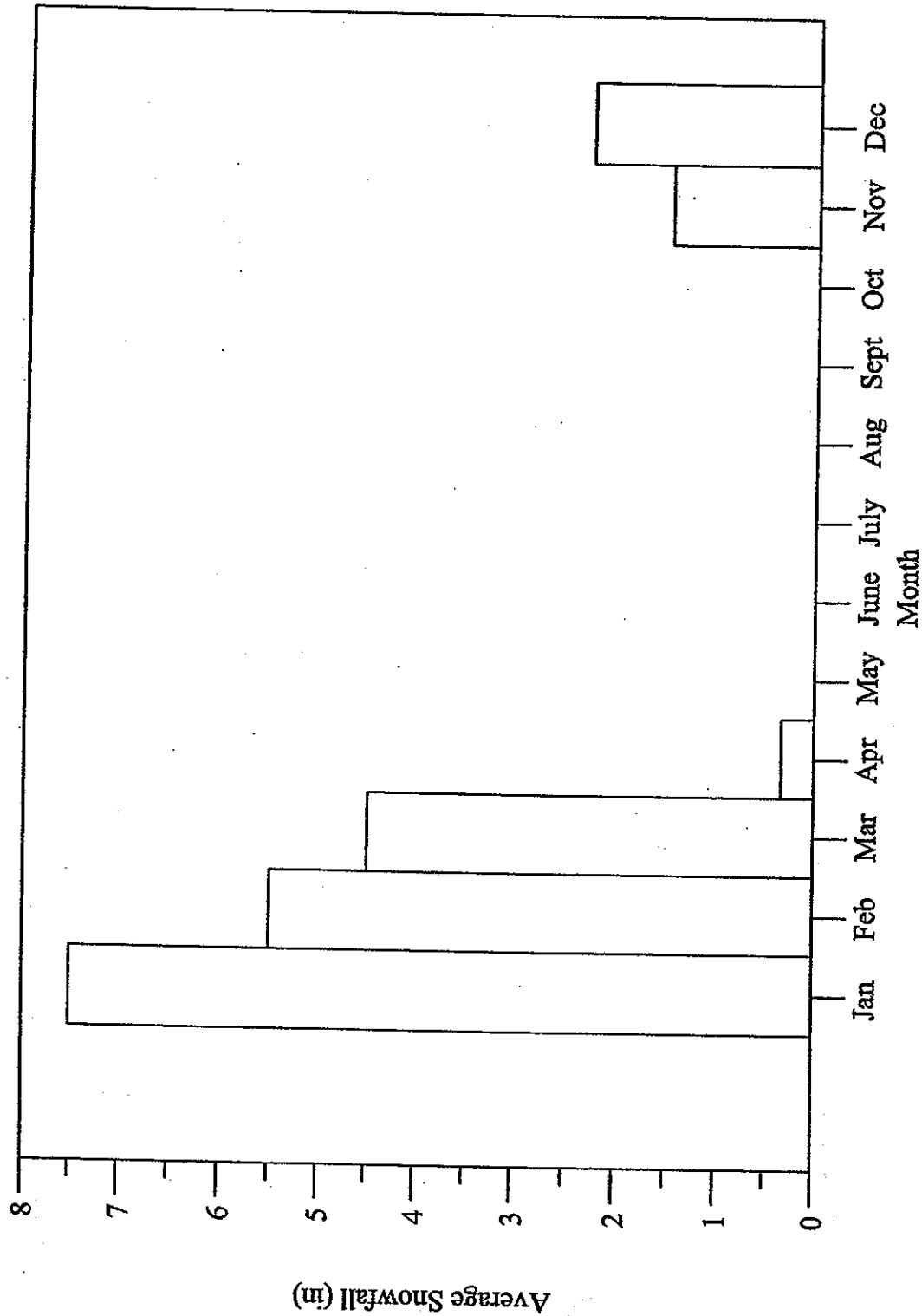


Figure 2.3-3 Monthly mean snowfall averaged over the period  
from 1951 to 1980 at Waverly, Ohio  
(Data Source: p. 863, Ruffner 1985)

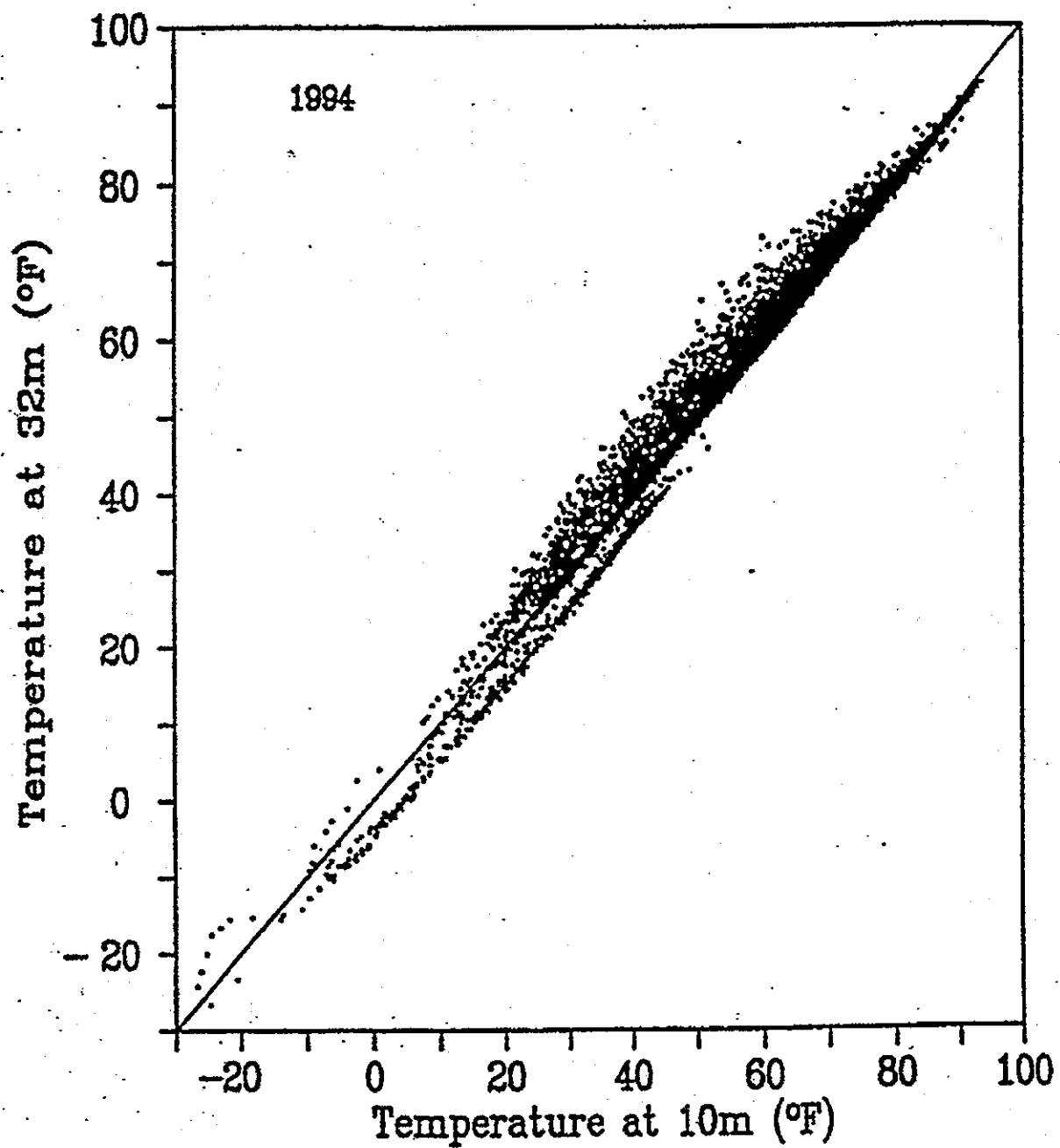


Figure 2.3-4. Hourly temperatures at 10-m and 32-m levels above ground at PORTS for 1994.

Figure 2.3-5.

NORMALS, MEANS, AND EXTREMES  
COVINGTON/CINCINNATI, OH (CVG)

LATITUDE:		LONGITUDE:		ELEVATION (FT):		TIME ZONE:		WEAN: 93814							
39° 02' 35" N		84° 40' 18" W		GRND: 882 BARO: 885		EASTERN (UTC + 5)									
ELEMENT		FOR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F	NORMAL DAILY MAXIMUM	30	38.0	43.1	53.9	64.7	74.4	82.4	86.4	84.8	78.0	66.4	53.6	42.7	64.0
	MEAN DAILY MAXIMUM	55	38.0	42.6	51.9	64.2	74.0	82.4	86.0	84.7	78.0	66.5	52.7	42.0	63.6
	HIGHEST DAILY MAXIMUM	41	69	75	84	89	93	102	103	102	98	88	81	75	103
	YEAR OF OCCURRENCE		1967	2000	1986	1976	1962	1988	1988	1962	1964	1963	1987	1982	JUL 1988
	MEAN OF EXTREME MAXS.	55	60.4	64.5	74.6	82.1	87.1	92.5	94.7	93.6	90.7	82.3	72.1	62.5	79.8
	NORMAL DAILY MINIMUM	30	21.3	25.0	33.8	42.7	52.9	61.6	66.1	64.2	56.8	44.9	35.7	26.4	44.3
	MEAN DAILY MINIMUM	55	21.7	24.7	32.6	42.7	52.2	61.0	65.4	63.6	56.4	44.7	35.0	26.1	43.8
	LOWEST DAILY MINIMUM	41	-25	-11	-11	15	27	39	47	43	31	16	1	-20	-25
	YEAR OF OCCURRENCE		1977	1996	1980	1997	1963	1972	1963	1986	1993	1962	1976	1989	JAN 1977
	MEAN OF EXTREME MINS.	55	-1.9	3.2	14.1	26.2	36.1	47.5	53.9	52.4	40.1	27.7	17.5	5.4	26.9
	NORMAL DRY BULB	30	28.1	31.8	43.0	53.2	62.9	71.0	75.1	73.5	67.3	55.1	44.3	33.5	53.2
	MEAN DRY BULB	55	29.9	33.7	42.3	53.4	63.1	71.6	75.6	74.2	67.4	55.6	44.0	34.0	53.7
	MEAN WET BULB	19	28.6	32.1	38.0	47.6	57.4	65.4	68.9	67.4	60.6	50.2	40.5	31.8	49.0
	MEAN DEW POINT	19	23.8	26.1	31.1	40.9	52.2	61.6	65.1	63.7	56.2	45.2	35.0	27.0	44.0
	NORMAL NO. DAYS WITH:														
	MAXIMUM ≥ 90°	30	0.0	0.0	0.0	0.0	0.7	4.3	7.8	5.6	2.1	0.0	0.0	0.0	20.5
	MAXIMUM ≤ 32°	30	12.0	7.6	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	6.6	28.1
	MINIMUM ≤ 32°	30	26.5	22.3	15.6	4.6	0.3	0.0	0.0	0.0	0.0	3.5	12.7	22.4	107.9
	MINIMUM ≤ 0°	30	3.2	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	6.2
H/C	NORMAL HEATING DEG. DAYS	30	1110	881	670	368	130	19	1	3	68	319	626	953	5148
	NORMAL COOLING DEG. DAYS	30	0	0	3	13	73	215	335	282	126	16	1	0	1064
RH	NORMAL (PERCENT)	30	72	70	67	63	67	69	72	72	73	69	71	74	70
	HOOR 01 LST	30	75	74	72	70	77	80	83	83	82	77	75	76	77
	HOOR 07 LST	30	78	78	77	76	80	82	85	88	88	83	80	80	81
	HOOR 13 LST	30	67	64	59	53	54	56	57	57	57	55	62	68	59
	HOOR 19 LST	30	69	65	60	54	58	59	61	63	66	64	68	72	63
PS	PERCENT POSSIBLE SUNSHINE	13	33	40	48	56	57	61	62	61	61	54	36	31	50
W/O	MEAN NO. DAYS WITH:														
	HEAVY FOG (VISBY≤1/4 MI)	40	2.5	2.0	1.6	0.9	1.2	1.5	1.7	2.6	2.8	2.0	1.6	2.5	22.9
	THUNDERSTORMS	56	0.7	0.8	2.5	4.3	6.0	7.3	7.9	7.1	3.0	1.4	1.2	0.5	42.7
CLOUDINESS	MEAN:														
	SUNRISE-SUNSET (OKTAS)														
	MIDNIGHT-MIDNIGHT (OKTAS)														
	MEAN NO. DAYS WITH:														
	CLEAR	1			5.0										
	PARTLY CLOUDY	1			1.0			1.0							
	CLOUDY	1	1.0	4.0	7.0		2.0	1.0							
PR	MEAN STATION PRESSURE (IN)	30	29.20	29.10	29.10	29.10	29.09	29.10	29.10	29.10	29.10	29.20	29.19	29.19	29.13
	MEAN SEA-LEVEL PRES. (IN)	19	30.12	30.11	30.06	29.99	29.99	29.97	30.01	30.04	30.06	30.11	30.11	30.14	30.06
WINDS	MEAN SPEED (MPH)	48	10.3	10.4	11.0	10.6	8.6	7.9	7.2	6.8	7.4	8.1	9.9	9.9	9.0
	PREVAIL.DIR (TENS OF DEGS)	32	21	21	21	21	20	21	22	22	21	20	21	21	21
	MAXIMUM 2-MINUTE:														
	SPEED (MPH)	7	41	39	45	45	36	41	45	41	36	48	40	40	48
	DIR. (TENS OF DEGS)		17	30	27	28	29	27	32	29	29	29	17	27	29
	YEAR OF OCCURRENCE		1996	1996	2002	2002	2002	2001	2001	2000	2002	2001	2001	2000	OCT 2001
	MAXIMUM 5-SECOND:														
	SPEED (MPH)	7	51	47	56	59	54	56	61	53	43	60	55	52	61
PRECIPITATION	DIR.. (TENS OF DEGS)		01	21	28	31	25	27	31	29	31	29	17	28	31
	YEAR OF OCCURRENCE		1996	2001	2002	1998	1999	2001	2001	2000	1997	2001	2001	2000	JUL 2001
	NORMAL (IN)	30	2.92	2.75	3.90	3.96	4.59	4.42	3.75	3.79	2.82	2.96	3.46	3.28	42.60
	MAXIMUM MONTHLY (IN)	55	9.43	6.72	12.18	9.77	9.48	9.61	8.70	7.71	8.61	8.60	7.51	7.90	12.18
	YEAR OF OCCURRENCE		1950	1955	1964	1998	1968	1998	2001	1982	1979	1983	1985	1990	MAR 1964
	MINIMUM MONTHLY (IN)	55	0.57	0.25	1.14	1.04	1.13	0.95	0.63	0.31	0.18	0.25	0.43	0.51	0.18
	YEAR OF OCCURRENCE		1981	1978	1960	1971	1964	1965	1997	1953	1963	1963	1949	1976	SEP 1963
	MAXIMUM IN 24 HOURS (IN)	55	4.33	2.84	5.21	3.31	3.71	3.45	4.28	3.52	4.54	4.47	3.36	2.96	5.21
SNOWFALL	YEAR OF OCCURRENCE		1959	1990	1964	1996	1956	1974	1988	1995	1979	1985	1948	1948	MAR 1964
	NORMAL NO. DAYS WITH:														
	PRECIPITATION ≥ 0.01	30	11.3	11.0	13.3	12.1	11.1	10.4	10.1	9.2	8.3	8.4	10.8	12.5	128.5
	PRECIPITATION ≥ 1.00	30	0.5	0.6	0.7	0.6	1.0	1.0	1.1	0.8	0.6	0.7	0.7	0.5	8.8
	NORMAL (IN)	30	7.8	6.0	3.8	0.6	0.0	0.0	0.0	0.0	0.0	0.4	1.3	3.7	23.6
	MAXIMUM MONTHLY (IN)	55	31.5	19.9	13.0	3.7	0.2	0.0	0.0	0.0	0.0	0.0	6.2	12.1	31.5
	YEAR OF OCCURRENCE		1978	1993	1968	1977	1989	1993	1994	2000		1993	1966	1989	JAN 1978
	MAXIMUM IN 24 HOURS (IN)	55	12.8	12.6	9.8	3.5	0.2	0.0	0.0	0.0	0.0	5.9	9.0	7.5	12.8
SNOWFALL	YEAR OF OCCURRENCE		1996	1998	1968	1977	1989	1993	1994	2000		1993	1966	1990	JAN 1996
	MAXIMUM SNOW DEPTH (IN)	54	14	19	11	5	0	0	0	0	0	4	8	8	19
	YEAR OF OCCURRENCE		1978	1998	1980	1987						1993	1966	1990	FEB 1998
	NORMAL NO. DAYS WITH:														
	SNOWFALL ≥ 1.0	30	2.4	1.9	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.1	7.3

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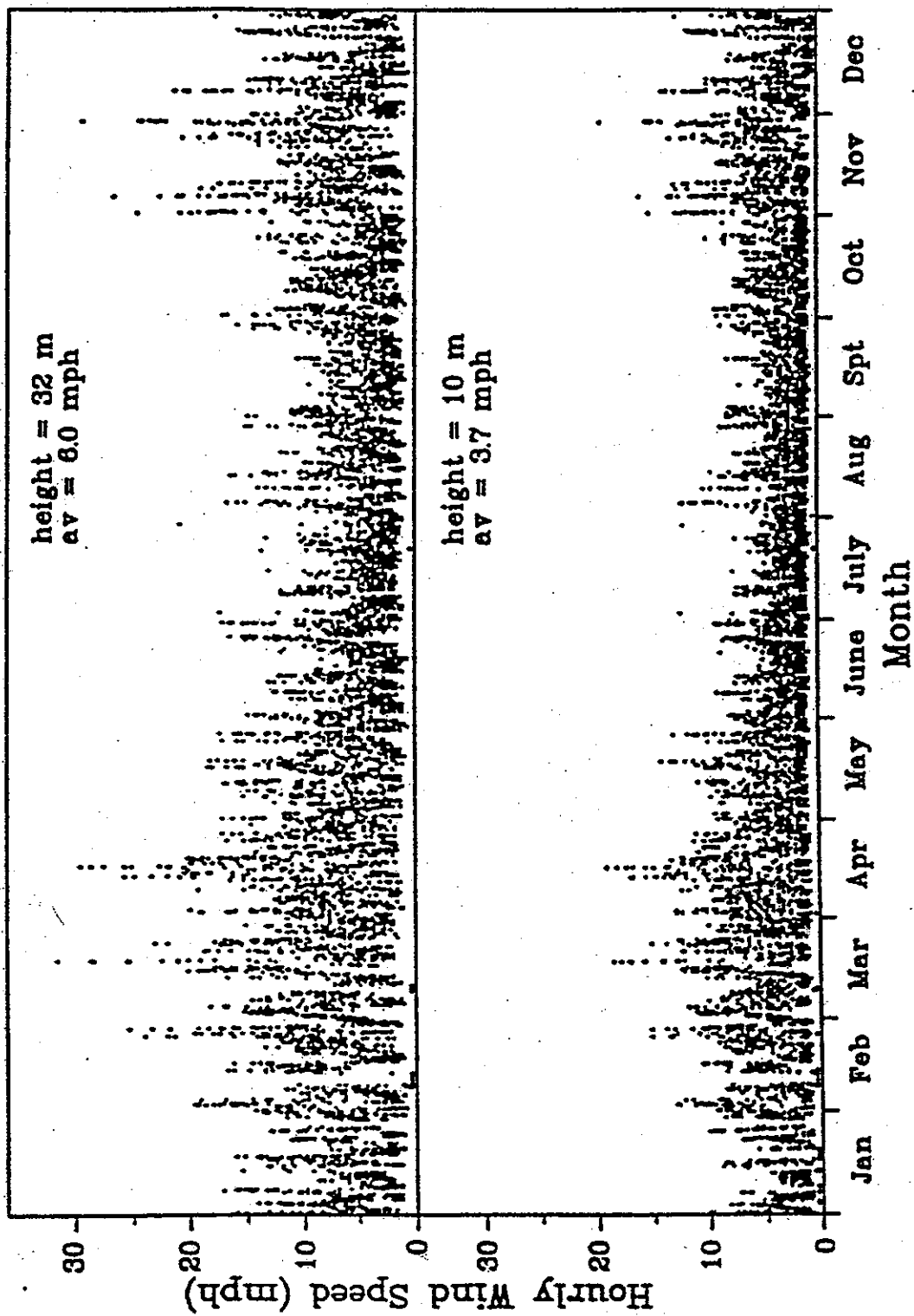


Figure 2.3-6. Hourly wind speeds at 10-m and 32-m levels above ground at PORTS for 1994.

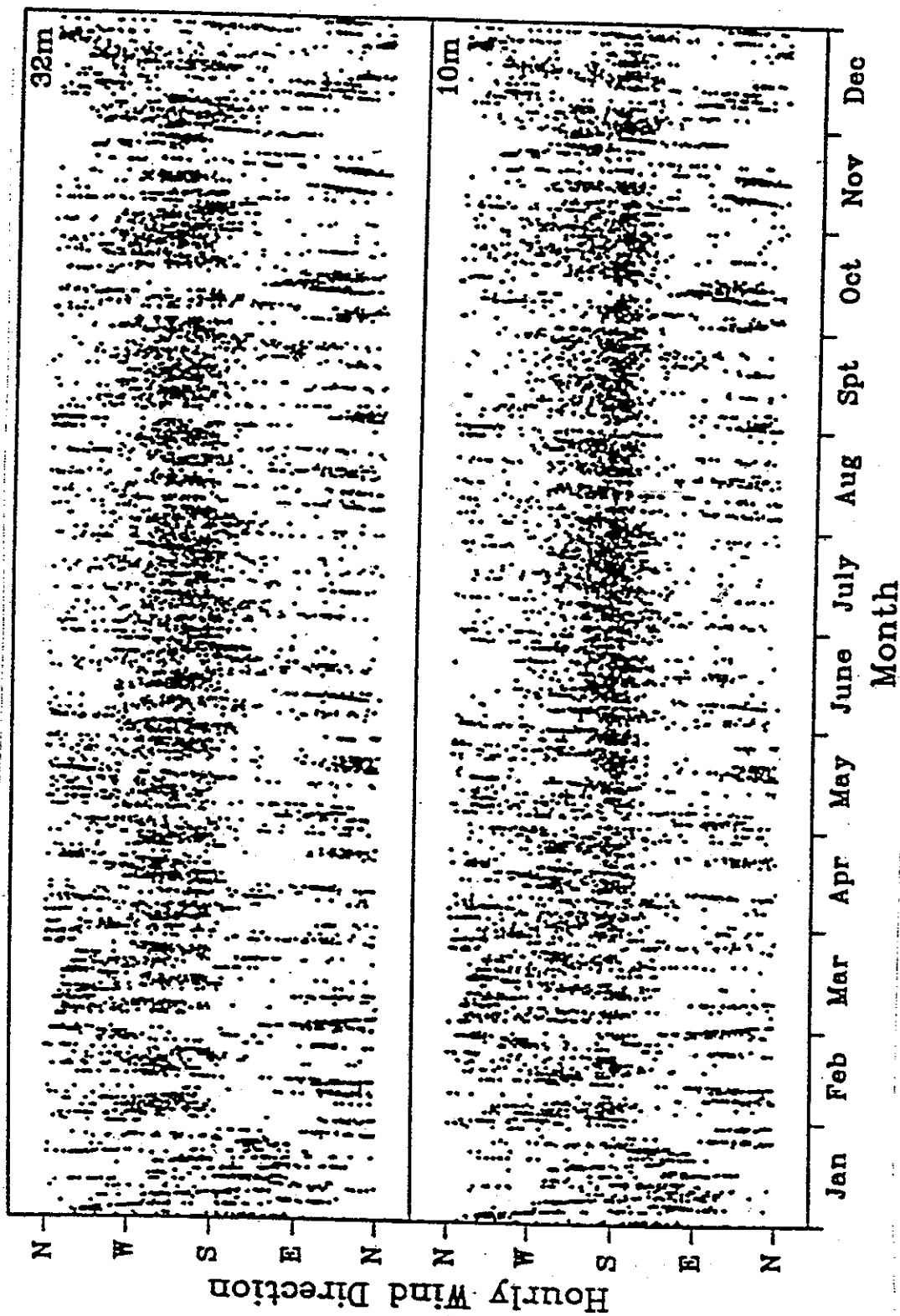
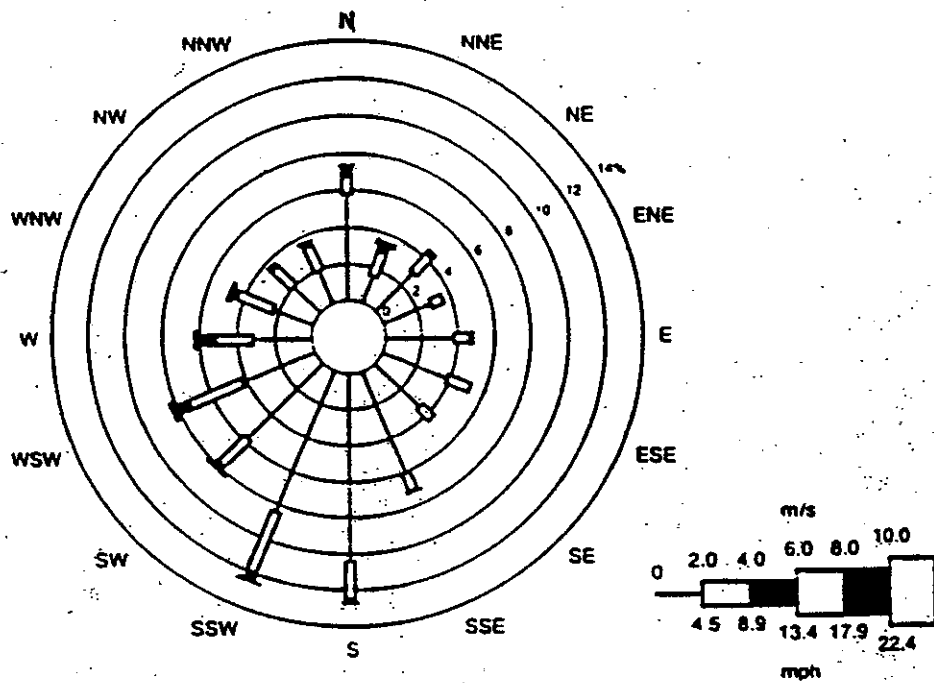


Figure 2.3-7. Hourly wind directions at 10-m and 32-m levels above ground at PORTS for 1994.



ORNL-DWG 94M-7069

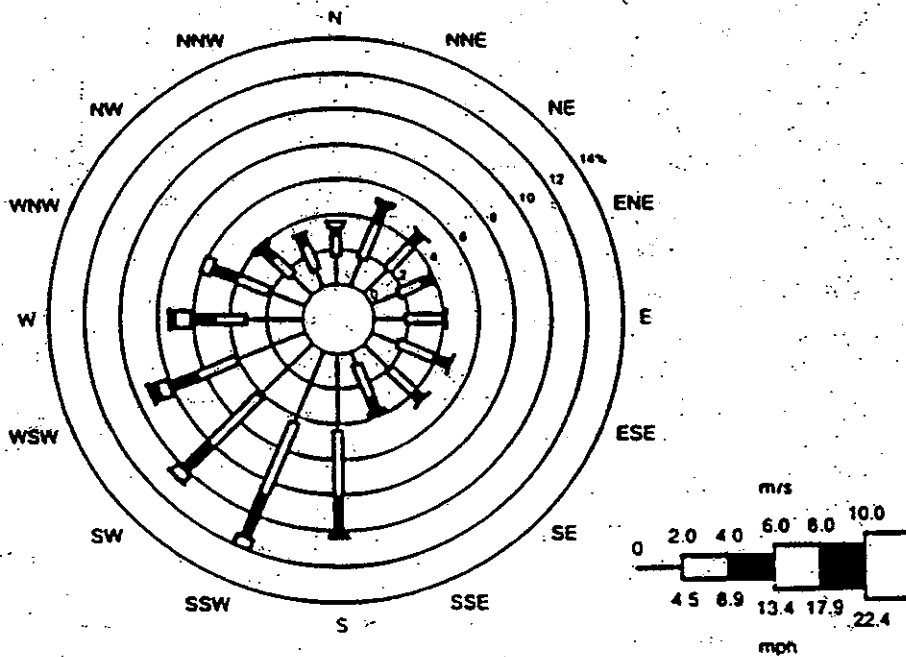


Fig. 2.3-8 Comparison of wind at 10-m (top) and 32-m (bottom) levels at PORTS for 1993. (Source: Kornegay et. al. 1994)

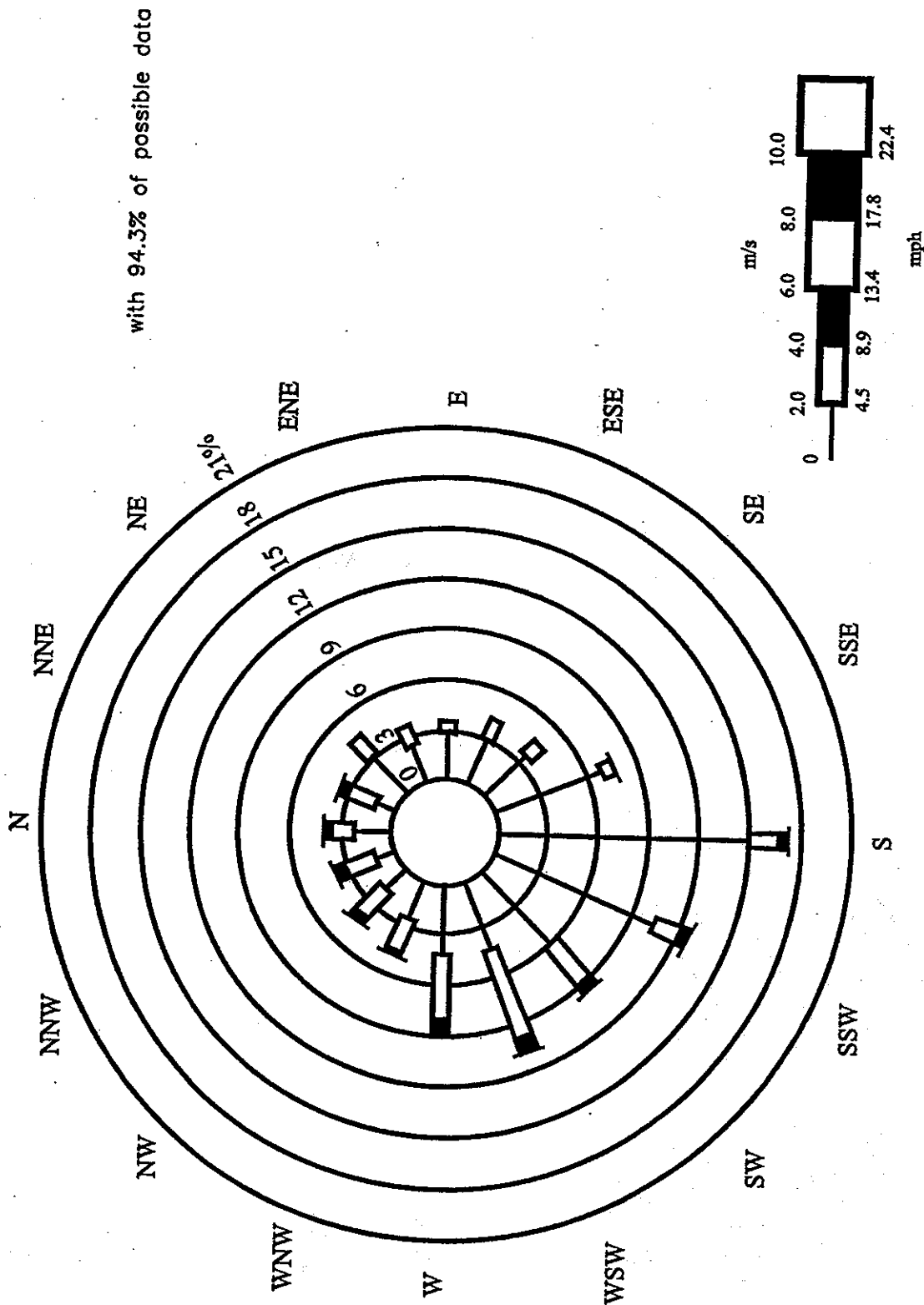


Figure 2.3-9 Average wind rose at 10-m level at PORTS 1992-94. (Source: Sharp 1995)

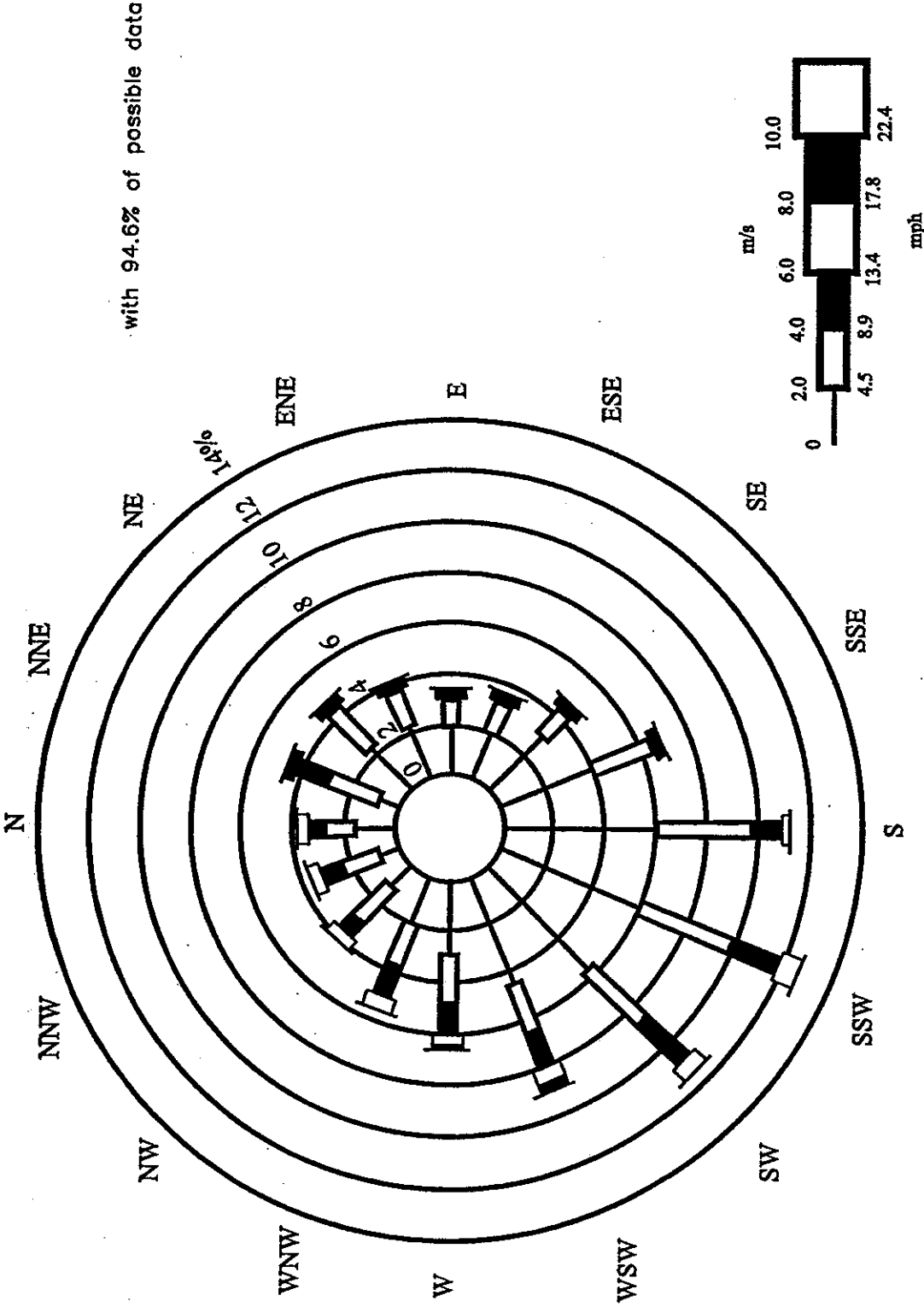


Figure 2.3-10 Average wind rose at 32-m level at PORTS 1992-94. (Source: Sharp 1995)

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## 2.4 SURFACE HYDROLOGY

### 2.4.1 Hydrologic Description

#### 2.4.1.1 Scioto River Basin

PORTS is located near the southern end of the Scioto River basin (Figure 2.4-1), which has a drainage area of 6,517 square miles (COE 1991, p. 71). The headwaters of the Scioto River form in Auglaize County in north central Ohio. The river flows 235 miles through nine counties in Ohio, and through the cities of Columbus, Circleville, Chillicothe, and Portsmouth (ERDA 1977, p. 3-4; COE 1991, p. 71). At Portsmouth, in Scioto County, the river empties into the Ohio River at river mile (RM) 356.5 (ORSANCOM 1988, p. 7). The slope of the Scioto River channel averages about 1.7 ft/mile between Columbus and Portsmouth (OHDNR 1963, p. 2). Five of the river's tributaries have drainage areas of over 500 square miles each: Olentangy River, Big Walnut Creek, Darby Creek, Paint Creek, and Salt Creek.

Upstream retarding basins are located, or potentially can be built for flood control, on tributaries throughout the Scioto River basin (Figure 2.4-1). The storage capacities of these reservoirs are limited. In units of 1000 acre-ft, some of the total storage capacities are as follows: Paint Creek, 145.0; Deer Creek, 102.5; Alum Creek, 124.0; Delaware, 132.0; Salt Creek, 100.3; Big Darby, 129.0; Upper Darby, 32.5; Mill Creek, 92.5; and Bellepoint, 88.2 (COE 1967, p. 11-88). Paint Creek, Deer Creek, Alum Creek, and Delaware Lakes, located about 55 to 105 miles above PORTS, are completed and in operation. Their full pool elevations are 845, 844, 901, and 947 ft, respectively. (COE 1991, pp. 72-74). Salt Creek Lake is in the inactive authorized category, and Big Darby and Mill Creek Lakes have been de-authorized (COE 1991, p. 72). Other existing reservoirs in the Scioto River basin are Lake White, Rocky Fork, Griggs, Hoover, and O'Shaughnessy, located about 6, 30, 88, 94, and 99 miles above PORTS, respectively (Figure 2.4-1) (OHDNR 1963, pp. 19-20).

The upstream retarding basin nearest PORTS forms Lake White along Pee Pee Creek, about 6 miles north of PORTS (Figure 2.4-2). The spillway of the reservoir is located at an elevation of 567 ft, while the roadway along the top of the dam is at an elevation of 577 ft (USGS 1979). Pee Pee Creek empties into the Scioto River south of Waverly at RM 40.

The U. S. Geological Survey (USGS) has collected stream-flow data for the Scioto River at Higby, Ohio, since 1930 (USGS 1992b, p. 144). The gauging station is located approximately 13 miles north of PORTS at RM 55.5. The drainage area of the Scioto River basin above Higby is 5130 square miles. The river flows measured at Higby from 1930 to 1991 range from 177,000 cubic feet per second (cfs) on January 23, 1937, to 244 cfs on October 23, 1930, and average 4,654 cfs (USGS 1992b, p. 144). The 1937 flood had a peak water elevation of 593.7 ft. The consecutive 7-day minimum discharge of record is 255 cfs, which occurred during October 19-25, 1930 (COE 1966, Table 9).

Water in the vicinity of PORTS is available from Lake White, the Scioto River, and groundwater supplies (ERDA 1977, p. 3-35). Most of the water used is taken from groundwater. Three municipal water supply facilities are located in the segment of the Scioto River between Higby and the confluence with the Ohio River (and all three use groundwater wells). Both Waverly and Piketon, located at RM 40

and 34, respectively, use groundwater wells. Their 1975 water use rates were 1.1 cfs and 0.54 cfs, respectively (OHDNR 1963, p. 7; ERDA 1977, p. 3-37). The city of Portsmouth has a population of 22,676 and uses water from the Ohio River through an intake at the Ohio River at RM 350.8, which is 5.7 miles upstream from the mouth of the Scioto River (ORSANCOM 1988, p.34). The pumping rate is about 11 cfs.

In 1975, the rural domestic groundwater use in the county was estimated to be 1.8 cfs (ERDA 1977, p.3-37); wells located in the vicinity of PORTS are shown in Figure 2.4-3.

Water used at PORTS normally comes from groundwater (Saylor et al. 1990, p. 5-29) (Figure 2.4-3). Of an average 19 cfs, 15 cfs is for cooling water makeup and 4 cfs for sanitary purposes (PMD and ECD 1989, app. 3). Currently, all water is supplied by wells in the Scioto River alluvium. These wells are located near the east bank of the Scioto River, downstream from Piketon. Four well fields (X-605G, X-608A, X-608B, and X-6609) have the capacity to supply reliably between 36.4 and 40.2 cfs.

#### 2.4.1.2 The PORTS Area

PORTS is located about 2.5 miles east of the confluence of the Scioto River and Big Beaver Creek near RM 27.5 (Figure 2.4-2). The plant site occupies an upland area bounded on the east and west by ridges of low-lying hills that have been deeply dissected by present and past drainage features. The plant nominal elevation is 670 ft, which is about 130 ft above the normal stage of the Scioto River. Both groundwater and surface water at PORTS are drained from the plant site by a network of tributaries of the Scioto River.

Both Big Beaver and Little Beaver creeks receive runoff from the northeastern and northern portions of PORTS. Little Beaver Creek, the largest stream on the property, flows northwesterly just north of the main plant area (Figure 2.4-2). It drains the northern and northeastern parts of the main plant site (Figure 2.4-4) before discharging into Big Beaver. About 2 miles from the confluence of the two creeks, Big Beaver Creek empties into the Scioto River at RM 27.5 (Figure 2.4-2). Upstream from the plant, Little Beaver Creek has intermittent flow throughout the year.

In the southeast portion of the site, the southerly flowing Big Run Creek (Figure 2.4-2) is situated in a relatively broad, gently sloping valley where significant deposits of recent alluvium have been laid down by the stream (Rogers et al. 1989, p. 8). This intermittent stream receives overflow from the south holding pond (X-230K), which collects discharge of storm sewers on the south end of the plant site. Big Run Creek empties into the Scioto River about 5 miles downstream from the mouth of Big Beaver Creek (Figure 2.4-2).

Two unnamed intermittent streams drain the western portion of the plant site (Figures 2.4-2 and 2.4-4). The stream in the site's southwest portion flows southerly and westerly in a narrow, steep-walled valley with little recent alluvium. It drains the southwest corner of the facility via the southwest holding pond. The stream near the west central portion of the plant site flows northwesterly and receives runoff from the central and western part of the site via the west drainage ditch. Both unnamed streams flow directly to the Scioto River and carry only storm water runoff (Rogers et al. 1989, p. 8).

Little Beaver Creek receives 39 percent of the total PORTS effluents, Big Run Creek, 9 percent,

and the two unnamed tributaries, 25 percent. The remaining 27 percent is discharged directly to the Scioto River through two pipelines (DOE 1987, p. 3-26). Treated effluents from a sanitary sewage plant are conveyed about 2 miles to the Scioto River via a 15-in. vitreous clay sewer line at Outfall 003; blowdown from the recirculating cooling water system enters the Scioto via Outfall 004 (DOE 1987, pp. 3-29, 3-33).

#### **2.4.1.3 Site and Facilities**

The PORTS nominal elevation is 670 ft, which is about 130 ft above the normal stage of the Scioto River. The top-of-slab floor elevations for the three process buildings were estimated from the roof elevations and the building heights and are all greater than 670 ft. (Johnson et al. 1993, pp. 4-41 to 4-48 and ERDA 1977, pp. 2-20 to 2-30). Elevations of surrounding areas and roadways (Johnson et al. 1993, p. 3-6; PORTS 1982) are shown in Figure 2.4-5. Their locations relative to Little Beaver and Big Run Creeks and to local drainage ways and storm sewer outfalls are shown in Figures 2.4-4 through 2.4-6.

Storm water that falls at PORTS is drained to local Scioto River tributaries by storm sewers that convey the runoff to a system of 14 outfalls as shown in Figure 2.4-6. The flow of storm water is further controlled by a series of holding ponds downstream from the storm sewer outfalls (see Figure 2.4-7).

The perimeter road, as shown in Figure 2.4-4, serves as a hydrologic boundary that prevents storm water runoff from backing up into the main process buildings, X-326, X-330, and X-333. Once storm water has been discharged onto the outer side of the perimeter road to the north, west, and south, the water flows downhill to local creeks and runs. To the east and southeast, the perimeter road acts as a diversion dam that directs storm water runoff to Big Run Creek. The northeastern corner of the perimeter road protects the main process buildings from flooding that could occur if the X-611B sludge lagoon dam failed. The relationship of storm water holding ponds, located along the outside of the perimeter road shown in Figure 2.4-7, to the topographic elevations, indicated in Figure 2.4-4, emphasizes the overall function of the PORTS surface water drainage system that has been described here (Johnson et al. 1993, p. 3-6).

Water used at PORTS is supplied by wells sunk into the Scioto River alluvium. The raw water is pumped through a 48-in. waterline (ERDA 1977, p. 3-9) to the water treatment plant, X-611, located near the northeastern corner of the site just outside the perimeter road (Figure 2.4-7). Pumphouse X-608, near the well fields, can also pump water from the Scioto River and is a backup system that is used only when the well systems are unable to produce sufficient water to meet the plant demand (ERDA 1977, p. 2-113). The well fields and the X-608 pumphouse may expect flooding (ERDA 1977, p. 3-8), although all equipment in X-608 is located above the 571-ft level.

#### **2.4.2 Flood History**

The average annual discharge at the Higby station for the period of record (1930-1991) is 4,654 cfs, while the maximum discharge of record is 177,000 cfs observed on January 23, 1937 (USGS 1992b, p. 144). The stage of the 1937 flood was 593.7 ft above mean sea level (MSL). The historical flood stage of the Scioto River next to PORTS was estimated to be 556.7 ft by using the estimate that the

Scioto River drops approximately 37 ft between the Higby gauging station (RM 55.5) and the mouth of Big Beaver Creek (RM 27.5) (Wang et al. 1992, p. 8, Table 2.1). Elevations for floods (with three recurrence intervals) at the confluence of the Scioto River and Big Beaver Creek (RM 27.5), estimated by the U. S. Army Corps of Engineers (Wang et al. 1992, p. 8), are compared with the PORTS nominal grade elevation in Table 2.4-1.

Since PORTS has a nominal elevation of about 670 ft above MSL (Figure 2.4-5) and about 113 ft above the historical flood level for the Scioto River in the area, PORTS has not been affected by flooding of the Scioto River.

#### **2.4.3 Probable Maximum Flood**

The plant elevation is greater than the maximum historic levels recorded for the Scioto River in the area and the 500 year flood predicted by the U.S. Army Corps of Engineers. However, a calculation of the "probable maximum flood" (PMF) was also performed. The details of a method of calculating the PMF are discussed in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59, (NRC 1977, App. B). It is based on the drainage area and the location of the watershed involved. The drainage area of the Scioto River basin above Higby is 5131 square miles (USGS 1992b, p. 144) and that of the whole basin is 6517 square miles (COE 1991, p. 71). The drainage area of the Scioto River above PORTS (RM 27.5) is between those two values. A conservative estimate for the PMF discharge of the Scioto River at either Higby or PORTS is approximately 1,000,000 cfs. This value is used as the PMF discharge of the Scioto River at PORTS, which including the wind/wave activity contribution, would correspond to a flood level of 571 ft., well below the nominal 670 ft. elevation of PORTS.

Two widely accepted probabilistic methods, the log Pearson III distribution and the Gumbel method, have been considered. The 10,000-year flood discharges of the Scioto River at Higby determined with these two methods are 526,000 and 280,000 cfs, respectively. Both of these discharge rates are smaller than that of the PMF. The PMF is, therefore, the bounding event in determining the evaluation basis loads from flooding for PORTS.

Conservative estimates indicate that the failure of upstream dams would not threaten the safety at PORTS because of the high nominal plant grade elevation (Wang et al. 1992, App. A). In addition, the limited storage capacities of the reservoirs, the large stream distances of these dams from PORTS, and friction and form losses would make the actual wave heights even smaller than the estimated values. Discharges were considered of dam failures at full pool combined with that of either a 25-year flood or one-half of the PMF of the Scioto River. The result involving one-half of the PMF would result in a higher value, which is also somewhat greater than that of the PMF. However, this combined extreme flood would not threaten the safe operations of PORTS because of the high nominal plant grade elevation, similar to the case of the PMF.

##### **2.4.3.1 Effects of Local Intense Precipitation**

##### **Storm Intensities and 10,000-Year Storms**

The U.S. Weather Bureau has published values of the total precipitation reaching the ground for

durations from 30 minutes to 24 hours and return periods from 1 to 100 years (Hershfield 1963). The results for the geographic locale including PORTS are summarized in Table 2.4-2. Values for 10,000-year storms are extrapolated from smaller duration values using a least-squares method. The rainfall intensity for a given storm listed in Table 2.4-2 can be obtained by dividing the total precipitation by the duration.

To determine whether the influx of rainwater from a 10,000-year storm can be conveyed away from plant structures, the intensity vs. duration relation for 10,000-year storms at PORTS needs to first be established. This was done by adopting an established empirical intensity vs. duration relation and using values listed in the last row of Table 2.4-2 and a nonlinear least-squares methodology (Johnson et al. 1993, p. 4-2). The resultant graph is shown in Figure 2.4-8. At small durations, although the intensities are high, the total precipitations are small. At large durations, the reverse is true.

### Results for Creeks

Figure 2.4-9 shows the locations at PORTS where channel cross sections were evaluated and water levels were calculated in Big Beaver, Little Beaver, and Big Run Creeks and in two unnamed tributaries of the Scioto River. The stage-discharge relationships for the five streams were evaluated using the estimated cross sections and Manning's formula with  $n = 0.15$ , a value typical for flood plains and very poor natural channels (Johnson et al. 1993, p. 4-6). The peak runoffs of these streams can be calculated using the natural runoff model (Johnson et al. 1993, p. 2-3) and the intensity vs. duration relation shown in Figure 2.4-8. The maximum values of the peak runoffs, the corresponding durations, precipitations, and flood levels are listed in Table 2.4-3. Local floodings for different streams are caused by 10,000-year storms with differing duration values because each watershed drains a basin of a different size (Johnson et al. 1993, p. 4-8). The relatively large differences between nominal plant grade elevation and the calculated flood stage elevations for the five streams clearly indicate that the main process buildings would not be inundated by these streams during a 10,000-year storm.

### Results for Storm Sewers

In addition to the Manning's formula and the natural runoff model, the urban runoff model and an inflow-outflow balance method (Johnson et al. 1993, pp. 2-4 and 2-9) were also used to assess the storm sewers. In each case, the duration that gives maximum peak discharge is determined and used as the critical 10,000-year storm.

Nearly one-fourth of the 3800-acre PORTS site is drained by the storm sewer system. In the storm sewer analysis, the drained area was subdivided into 14 drainage areas with sizes ranging from 17 to 163 acres (Johnson et al. 1993, p. 4-13, Table 4.7). Flow velocities and volumetric discharge rates were determined from the pipe diameter, material type, and a conservative minimum slope of 0.001 at the outlets (Johnson et al. 1993, p. 4-9). The results indicate that PORTS would experience local ponding during a 10,000-year storm because the storm sewer system has insufficient capacity to convey the rainwater to the outfalls. The average depth of water around the base of the buildings would range from 3.91 to 5.08 in. The existing storm sewer system would require from approximately 1.8 to 9.9 hours to drain the excess storm water to the outfalls (Johnson et al. 1993, p. 4-14).

The results presented above are conservative. For example, once each individual catchment is

inundated, storm water tends to flow from catchments having higher water levels to ones having lower water levels. Pressurization of the storm sewer system after filling with water has been neglected. Runoff from streets and local topography, either natural or manmade, has also been neglected. These factors tend to reduce the calculated water levels.

The effect of a clogged storm sewer system on the ponding depth has been considered (Johnson et al. 1993, p. 4-15). The ponding levels computed with an inoperable sewer system are similar to the results obtained when the system is functional. The relative average water depths predicted by both analyses are similar in magnitude. Because the storm sewer flow is approximately one-fourth of the total 10,000-year storm flow, the overland drainage system is the dominant factor in determining the water depth at the base of the buildings. Thus local ponding levels can be controlled by keeping natural surfaces within the security fence grassed, mowed, and free of high weeds, and by keeping debris from blocking urbanized surfaces. This would prevent water from backing up to higher levels than those presented above. Additionally, the tunnels could be potentially affected due to infiltration of water; however, tunnels are only used for cable runs and are otherwise abandoned. It is unlikely that significant safety problems would develop from tunnel flooding. Ponding on the site is not expected to impact safe operations.

### Results for Ponds and Lagoons

To assess whether failures of the local dams could conceivably jeopardize the safety of critical systems, holding ponds, lagoons, and retention basins formed by these dams were considered in the local drainage analysis (Johnson et al. 1993, pp.3-36 to 4-39). They include the west drainage ditch; X-2230N west-central holding pond 2, X-2230M southwest holding pond 1, X-230K south holding pond, east drainage ditch, X-701B holding ponds (northwest, central, and southeast portions), storm sewer L, X-230L north holding pond, X-611B sludge lagoon, and X-611A lagoons (north, middle, and south lagoons) (Johnson et al. 1993, p. 4-37, Table 4.13). The only bodies of water that could affect the main process buildings are the X-611B sludge lagoon and the three portions of the X-701B holding ponds. The remaining water surface elevations are so far below the 670-ft minimum grade elevation of the main process buildings that further consideration is not warranted.

The X-701B holding ponds are located in the immediate vicinity of Outfalls D and E. After being remediated to the Ohio EPA's acceptance, the associated east and west containment ponds have been filled in, and only the central X-701B holding pond remains. Main process buildings are protected from this holding pond and the drainage ditch of the outfalls by a berm that rises to an elevation between 672 and 674 ft. This berm encompasses the X-701B holding pond and the Outfall D and E drainageway. The analysis demonstrates that this holding pond and outfall area would not overflow and inundate the main process buildings during an approximate 10,000-yr extreme storm (Johnson et al. 1993, p. 4-37).

The water level elevation of the X-611B sludge lagoon at 668.8 ft is close to the 670-ft minimum grade elevation at the main process buildings. The elevation of the top of the dam forming the lagoon is 676.3 ft and exceeds the 670-ft minimum. However, when the conservative estimate of flood wave height (4/9 of the dam height) is used, the flood elevation resulting from a break in the dam would be only 652.8 ft. The flood wave clearly poses no threat to the PORTS plant proper because it could not overtop Perimeter Road (Johnson et al. 1993, p. 4-37).

## Results for Ditches and Culverts

The PORTS storm sewer system discharges through each of the outfalls shown in Figure 2.4-6 into a series of ditches, culverts, and holding ponds, with eventual discharge to nearby creeks or to the Scioto River directly.

Outfalls at PORTS have been analyzed to predict their response during a 10,000-year storm (Johnson et al. 1993, pp. 4-16 to 4-39). Outfalls A, B, J, N, and O (Figure 2.4-6) were treated as broad-crested weirs with no storm water flowing through culverts that pass beneath roads and railroad tracks. None of the calculated water surface elevations for these outfalls results in local flooding of the main process buildings located at a 670-ft grade elevation. Discharge from Outfalls C, K, L, and M occurs along the outer periphery of Perimeter Road where steep slopes promote the flow of rainwater away from the plant. Local flooding of the main process buildings attributable to these outfalls is not anticipated.

Outfalls D and E (Figure 2.4-6) discharge storm water to two culverts that pass beneath Perimeter Road to permit drainage to Little Beaver Creek. The calculated water surface behind these two culverts is below the grade elevation at the main process buildings. During an extreme storm, water surface will first rise above the inlets of the culverts, but pressurization and a concomitant increase in total discharge will then enable these culverts to pass the rainwater received. If clogging of the two culverts below Outfalls D and E occurs, the main process buildings could be flooded locally because Perimeter Road rises to an elevation of 674 ft at this location.

The remaining 3 of the 14 outfalls, Outfalls F, G, and H (Figure 2.4-6), associated with X-230K pond and Big Run Creek, were also analyzed (Johnson et al. 1993, pp. 4-29 to 4-36). Although some of the culverts would be incapable of carrying the influx of rainwater and some overbanking would happen during a 10,000-year storm, water surface elevations computed for flows in all of the related culverts are below grade elevation at the main process buildings and would not cause local flooding at these buildings during a 10,000-year storm.

## Effects of Ice and Snow

PORTS has a generally moderate climate. Winters in the area are moderately cold. On the average, there are 112 days per year below 32 °F, but only 3 days per year at or below 0 °F (ERDA 1977, p. 3-17). The average annual snowfall is 22 in. To estimate the extreme snowfall at PORTS, values for three surrounding cities are used. The maximum monthly snowfalls of record for Columbus (Ohio), Charleston (West Virginia), and Louisville (Kentucky) are 34.4, 39.5, and 28.4 in., respectively, measured in January 1978 (Weather Almanac 1992, pp. 557, 697, and 821). If the largest value among the three is used for PORTS, and if an average density of 0.1 for freshly fallen snow is assumed (Linsley Jr. et al. 1982, p. 82), this snowfall corresponds to 3.95 in. of rainfall.

### 2.4.3.2 Probable Maximum Flood on Rivers

The maps and the procedure outlined in Sect. B.3.2.2 of NRC Regulatory Guide 1.59 were used to estimate the PMF discharge. The log-log plot of the data approximates a straight line. The drainage area of the Scioto River basin above Higby is 5131 square miles (USGS 1992b, p. 144), above Piketon is 5,824

square miles (OHDNR, 1963 Table 13), and above the mouth of the river is 6,517 square miles (COE 1991, p. 71). The drainage area of the Scioto River above PORTS (RM 27.5) is estimated from these values to be 6,000 square miles. PMF discharge of the Scioto River at PORTS as taken from the log-log plot is approximately 1,000,000 cfs. This value is adopted as the PMF discharge near PORTS (Wang et al. 1992, p. 8).

### **Coincident Wind Wave Activity**

A conservatively high wind velocity of 40 mph blowing over land from the most adverse direction was adopted to associate with the PMF elevation at PORTS in accordance with Alternatives I and II in Appendix A of NRC Regulatory Guide 1.59. The fetch length near PORTS during the PMF of the Scioto River was estimated from USGS topographic quadrangle maps having a 1:24,000 scale to be 1 mile. The increase of flood elevations of the Scioto River near PORTS due to this wind wave activity was estimated to be 1.8 ft (Linsley and Franzini 1972, p. 181, Fig. 7-11). The PMF plus this coincident wind wave activity would have a flood stage of 571 ft.

### **Comparison of Flood Levels with PORTS Elevations**

The nominal, top-of-grade elevation at PORTS is 670 ft, about 99 ft above the PMF plus wind wave activity flood stage of 571 ft. The top-of-slab floor elevations for the three critical, safety-related process buildings have values ranging from 670.4 to 671.4 ft. These buildings, therefore, would not be inundated by the Scioto River during a PMF superimposed with wind wave activity.

The PORTS water supply facility near RM 32.5 of the Scioto River, pumphouse X-608, and groundwater well fields, may expect flooding (ERDA 1977, p. 3-8). Using the estimate that the Scioto River drops approximately 31 ft between the Higby gauging station (RM 55.5) and the bridge at Highway 23 (RM 34) (Wang et al. 1992, p. 8, Table 2.1), the flood stages of the Scioto River near the supply facility were estimated to be 575 ft for the PMF. All equipment in the X-608 pumphouse is located above the 571-ft level (ERDA 1977, p. 3-8). Thus, under extreme conditions, the water supply to the enrichment process cooling system can be affected by flooding. However, such impacts on the cooling system would not result in a release of UF<sub>6</sub>. The enrichment process can be sectionalized into an isolated cell configuration by closing strategic valves, and during severe conditions all or part of the cascade can be shut down.

### **2.4.4 Potential Seismically Induced Dam Failures**

Several dam failures are considered in this section. The domino-type failure of the O'Shaughnessy and Griggs on the Scioto River, failures of individual dams on the tributaries of the Scioto River, and individual dam failures combined with either a 25-year flood or one-half of the PMF of the Scioto River may result in flood elevations that are comparable or even greater than that of the PMF 569 ft. However, even when a conservative wave height of 41.3 ft is used, the PORTS site clearly would not be threatened by this cascade of dam failures because the nominal plant grade elevation is 670 ft, which is 130 ft higher than the normal Scioto River level.

### **2.4.5 Channel Diversions and Ice Formation on the Scioto River**

The ancient Newark River was a major channel for alluvium-bearing meltwater from the continental

glaciations (LETC 1978, p. 5-13). This river system ended when its deep valley and those of other major south-draining streams were partially filled with silt, sand, and gravel outwash. The present Scioto River was developed on top of this glacial outwash during the final retreat of glaciers from the area (Lee 1991, p. 4; Norris and Fidler 1969, p. 8). The Scioto River apparently has a smaller flow and hence a more restricted channel. Therefore, channel diversions of the lower stem of the Scioto River out of the ancient Newark River Valley are unlikely.

Ice occurs on all streams in the Ohio River basin, and during the severe January of 1963 more than 18 in. of ice was formed on the Ohio River tributaries (COE 1966, p. 10). Winters near the PORTS area are moderately cold. On the average, there are 112 days per year below 32 °F, but only 3 days per year at or below 0 °F (ERDA 1977, p. 3-17). Ice on the Scioto River should not affect the water supply to PORTS because the plant uses groundwater taken from near the river. Additionally, ice formation would not pose a threat of flooding to PORTS, given the high elevation of the plant relative to the river.

#### 2.4.6 Low Water Considerations

Water used at PORTS, an average of 19 cfs, can be supplied from wells in the Scioto River alluvium. The raw water is pumped through a 48-in water line (ERDA 1977, p. 3-9) to water treatment plant X-611 located near the northeastern corner of the site just outside the perimeter road. The pumphouse X-608 near the well fields can also pump water from the Scioto River and is a backup system that is used only when the well systems are unable to produce sufficient water to meet the plant demand (ERDA 1977, p. 2-113).

At the Higby gauging station, which is approximately 13 miles north of PORTS, the minimum river flow measured from 1930 to 1991 was 244 cfs on October 23, 1930 (USGS 1992b, p. 144). The consecutive 7-day minimum discharge record of 255 cfs occurred during October 19-25, 1930 (COE 1966, Table 9). The volumetric river flow is much greater than the PORTS water use.

#### 2.4.7 Dilution of Effluents

The average discharge of the Scioto River near PORTS is 4,654 cfs. Potentially, this discharge rate has a large capacity for reducing the concentration of received contaminants. For example, the uranium discharged from PORTS through the local drainage system to the Scioto River was estimated to be 45 kg during 1990 (Kornegay et al. 1991, p. 60). In 1990, the bulk of the uranium (76 percent) was discharged through Outfall 001 to Little Beaver Creek (Kornegay et al. 1991, p. 56). Assuming a full dilution, this would result in an average uranium concentration of  $1.1 \times 10^{-5}$  mg/L in the Scioto River.

**Table 2.4-1. Comparison of flood elevations of the Scioto River near PORTS with the plant nominal grade elevation.**

Recurrence interval	Elevation	
	Meters	Feet
50-year flood <sup>a</sup>	170.1	558.0
100-year flood <sup>a</sup>	170.8	560.3
500-year flood <sup>a</sup>	172.4	565.7
Historical record <sup>b</sup>	169.7	556.7
PORTS nominal grade	204.2	670.0

a. Estimates by U.S. Army Corps of Engineers (Rehme 1990; Wang et al. 1992, p. 8).

b. Estimated from records at Higby, 181.0 m (593.7) (USGS 1992b, p. 144), assuming the flood level at the mouth of Big Beaver Creek is 11.3 m (37 ft) lower.

**Table 2.4-2. Precipitation as a function of recurrence interval and storm duration for PORTS (Johnson et al. 1993, p. 4-2).**

Recurrence interval (year)	Storm duration (hour)						
	0.5	1	2	3	6	12	24
	Precipitation (in. <sup>a</sup> )						
1	0.85	1.06	1.34	1.44	1.75	2.04	2.43
2	1.04	1.28	1.57	1.71	2.02	2.44	2.70
5	1.36	1.66	1.98	2.14	2.52	2.98	3.41
10	1.52	1.93	2.30	2.52	2.98	3.40	3.90
25	1.75	2.24	2.64	2.92	3.38	3.91	4.55
50	1.96	2.51	2.97	3.16	3.78	4.20	4.93
100	2.16	2.73	3.22	3.48	4.00	4.88	5.26
10,000 <sup>b</sup>	3.46	4.45	5.15	5.57	6.42	7.49	8.32

a. 1 in. = 2.54 cm

b. Extrapolated values calculated using least-squares methodology.

Source: Hershfield 1963.

**Table 2.4-3. The 10,000-year flood levels and related information for the five local streams at PORTS.**

Stream	Basin size (mi) <sup>a</sup>	Slope (%)	Peak discharge (cfs) <sup>b</sup>	Duration (min)	Precipitation (in) <sup>c</sup>	Water level (ft) <sup>d</sup>
Big Beaver	70	0.265	222,605	201	5.73	591.1
Little Beaver	25	0.516	13,310	103	5.04	651.1
Big Run	4	0.8	4,944	59	4.42	644.2
Tributary (west-central)	4	4	4,944	59	4.42	646.3
Tributary (southwest)	3	4.6	4,188	55	4.33	625.1

a. 1 mi<sup>2</sup> = 2.59 km<sup>2</sup>

b. 1 cfs = 0.0283 m<sup>3</sup>/s

c. 1 in. = 2.54 cm

d. 1 ft = 0.305 m

Source: Johnson et al. 1993, pp. 4-9 and 4-10.

September 15, 1995

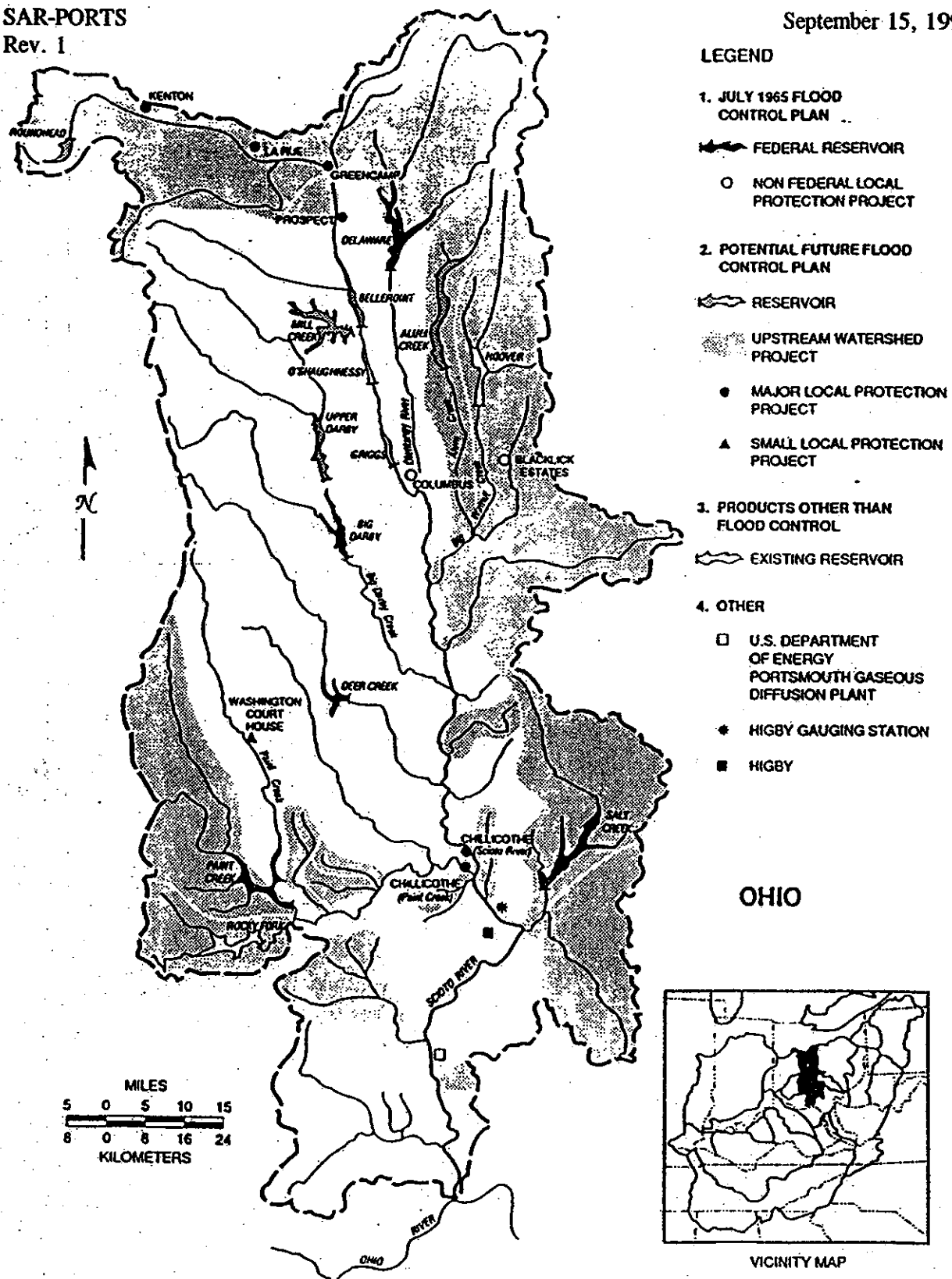


Figure 2.4-1. Scioto River watershed (COE 1967, p. 11-91).

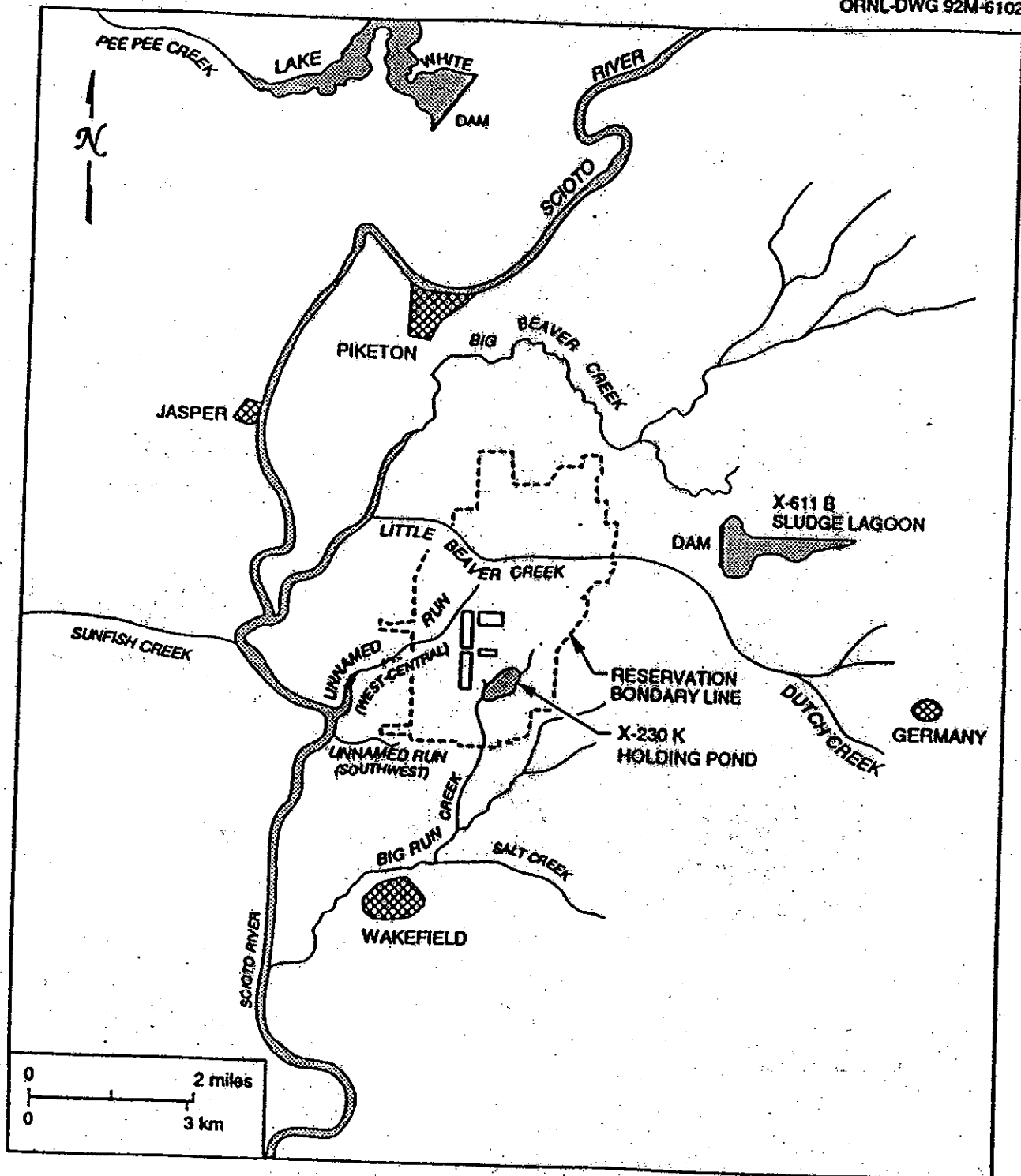


Figure 2.4-2. Location of rivers and creeks in the vicinity of PORTS (Johnson et al. 1993, p. 1-4).

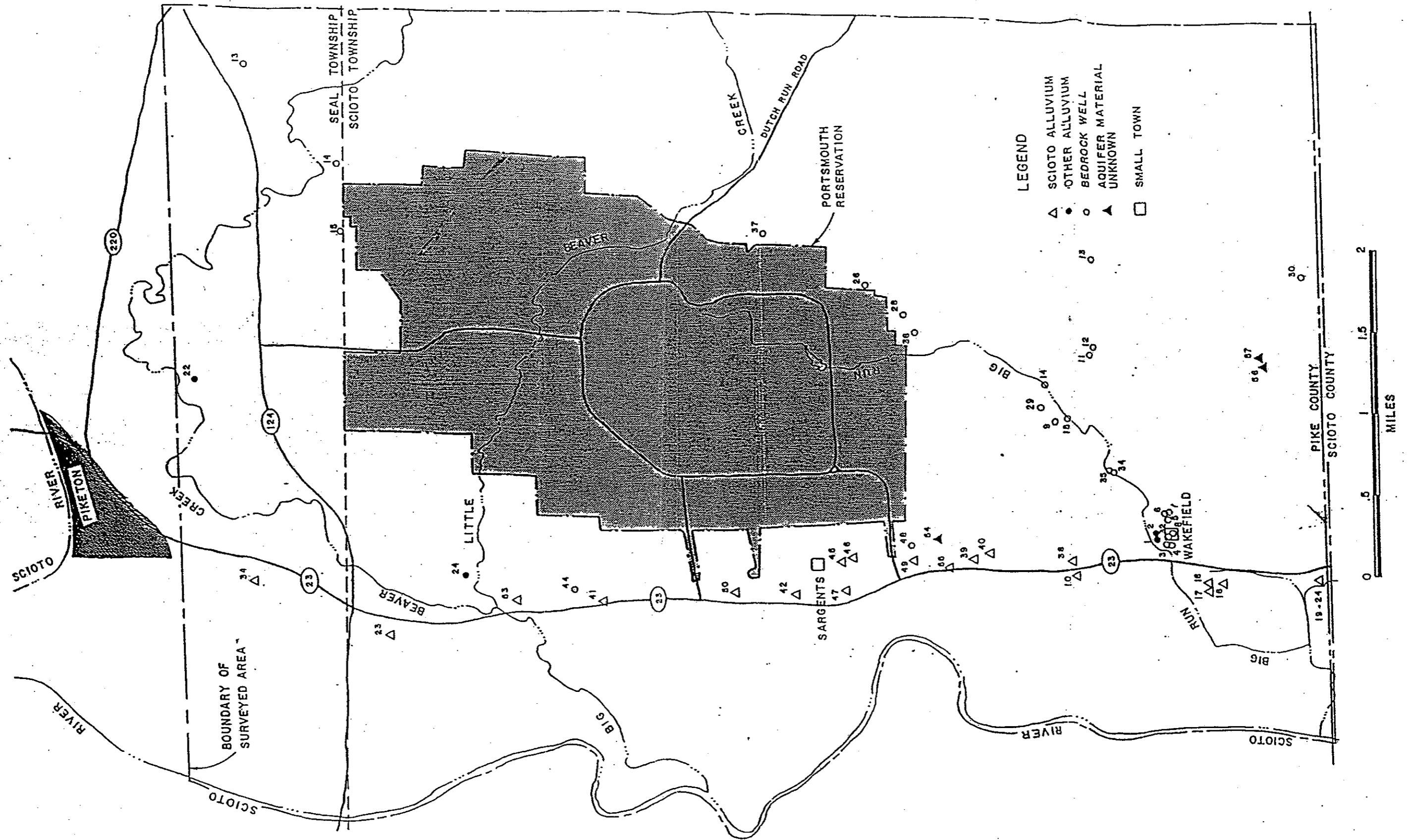


Figure 2.4-3. Located groundwater wells in the vicinity of PORTS (LETC 1982, Fig. 3.6; Saylor et al. 1990, p. 6-25).

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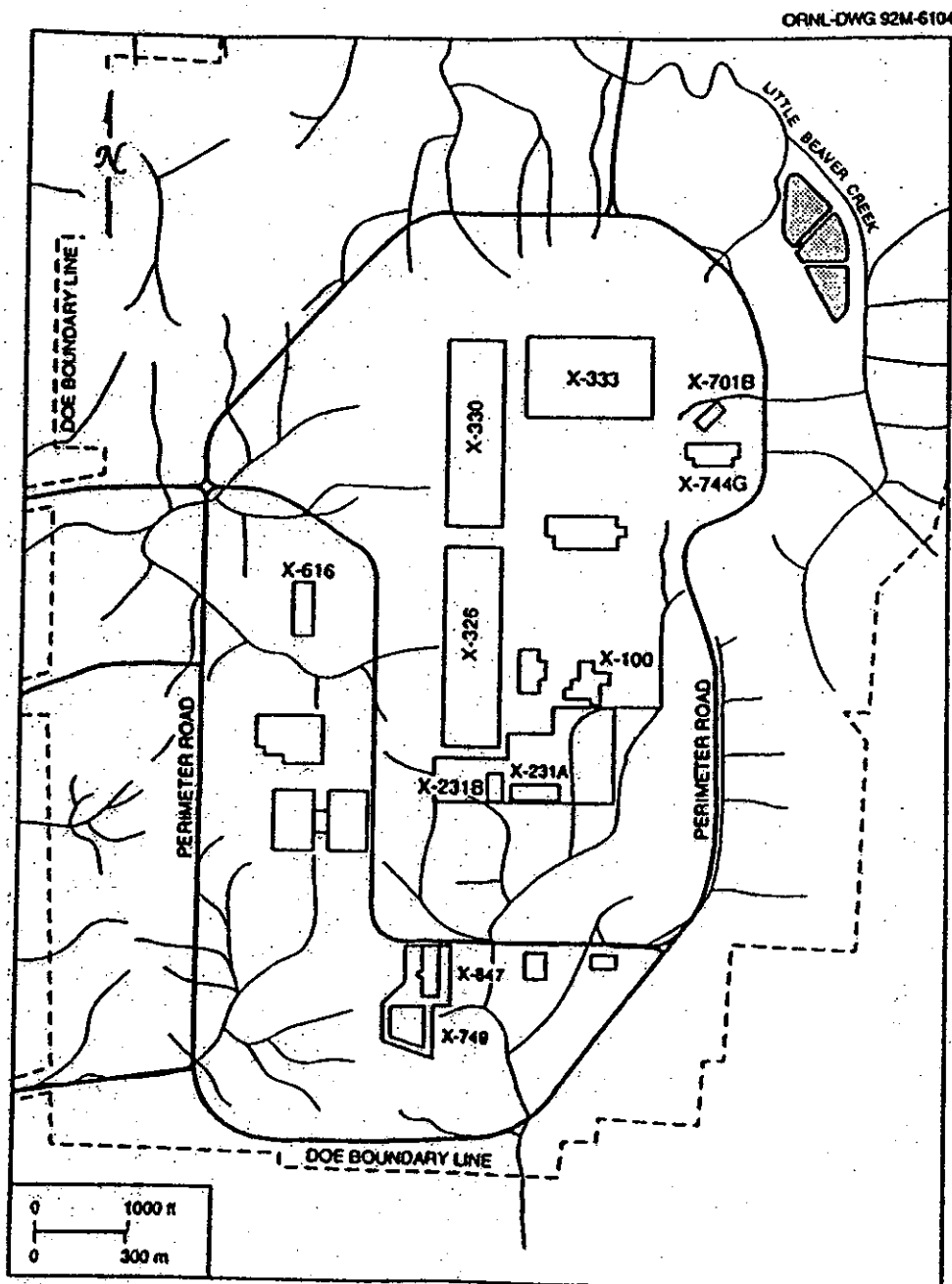


Figure 2.4-4. Local drainage at PORTS (Rogers et al., 1989, p.10; Johnson et al., 1993, p. 3-3).

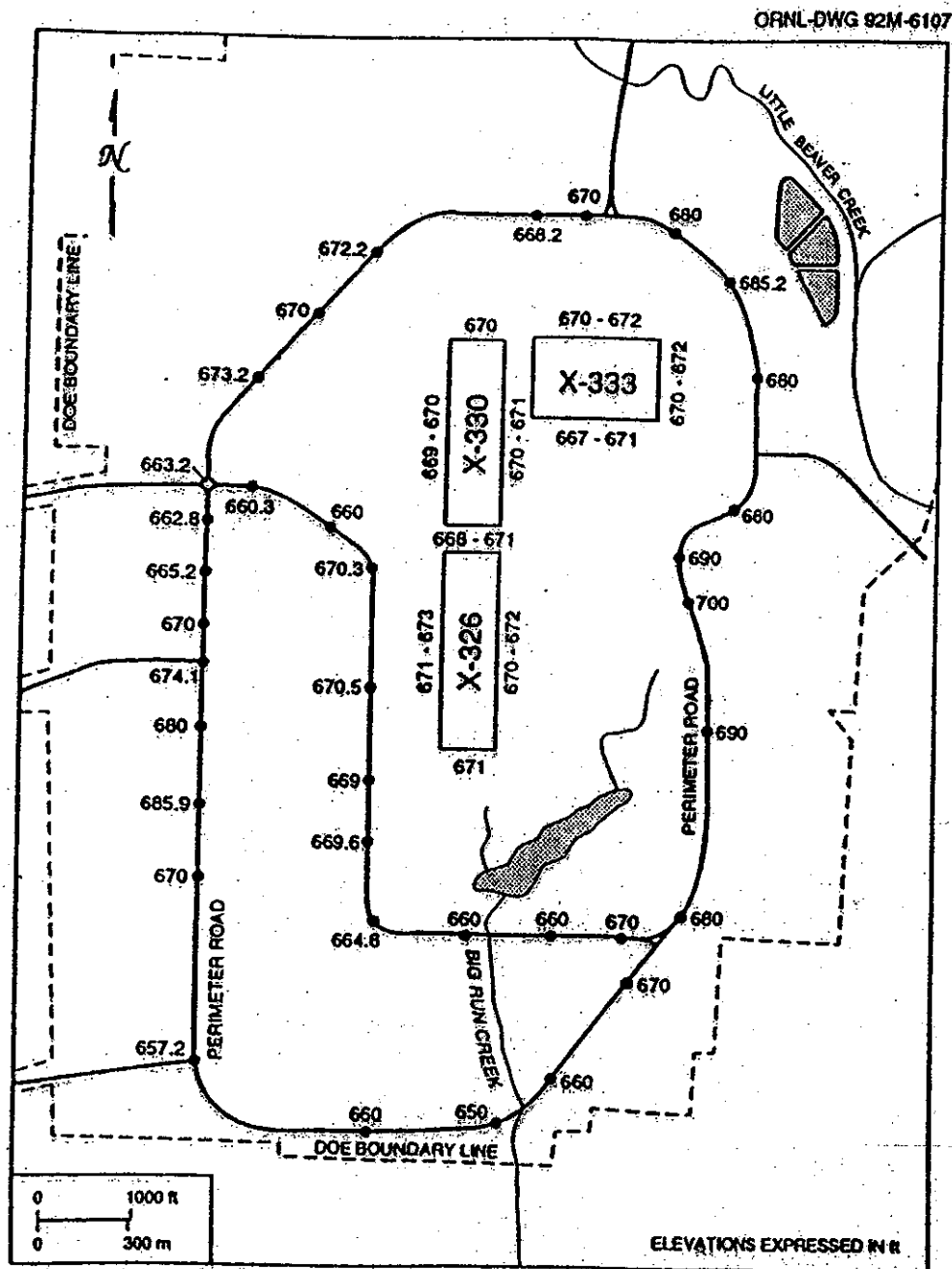


Figure 2.4-5. Elevations of roadways and of the surrounding areas of main process buildings (Johnson et al, 1993, p. 3-7).

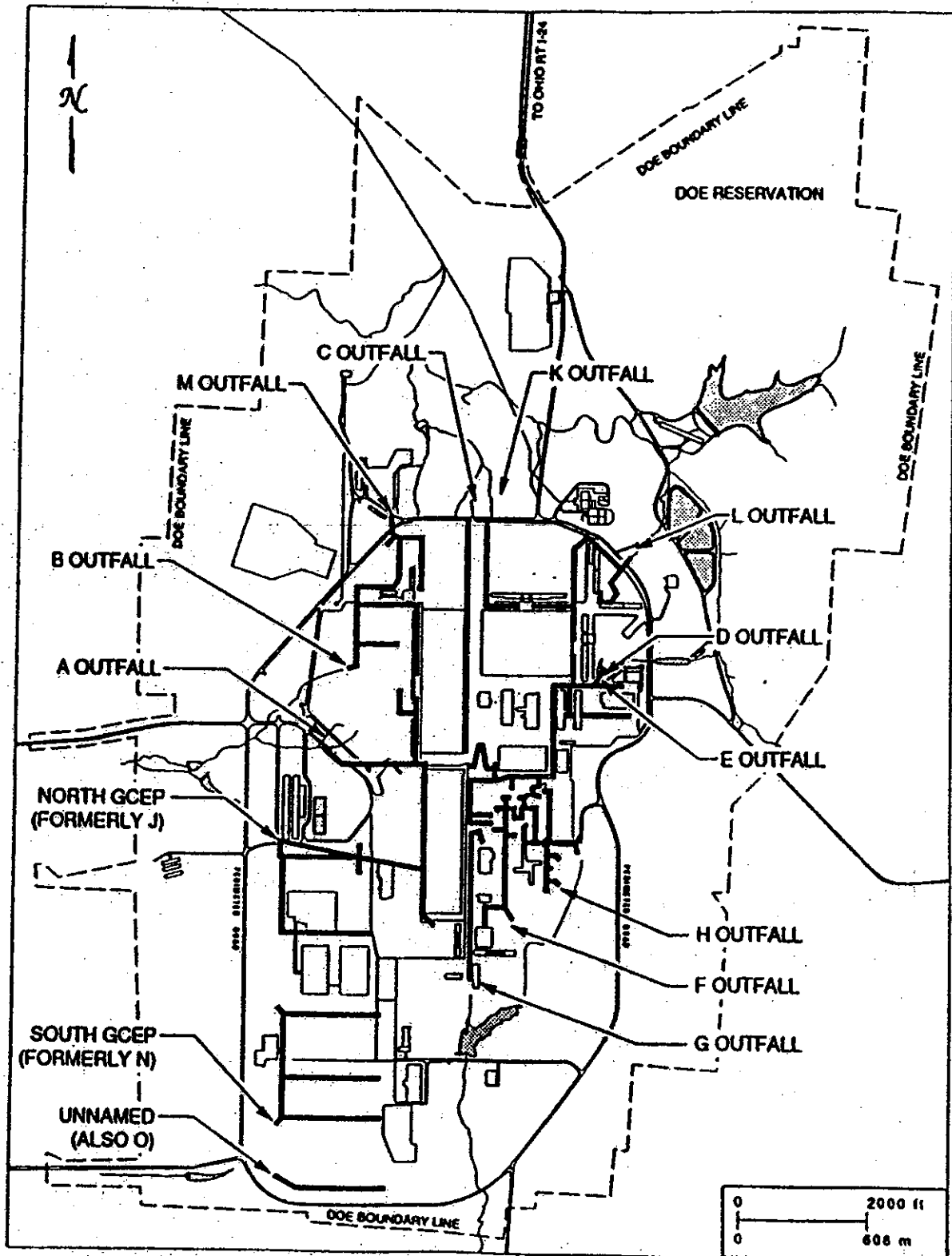


Figure 2.4-6. Storm sewer outfalls at PORTS (Johnson et al. 1993, p. 3-4).

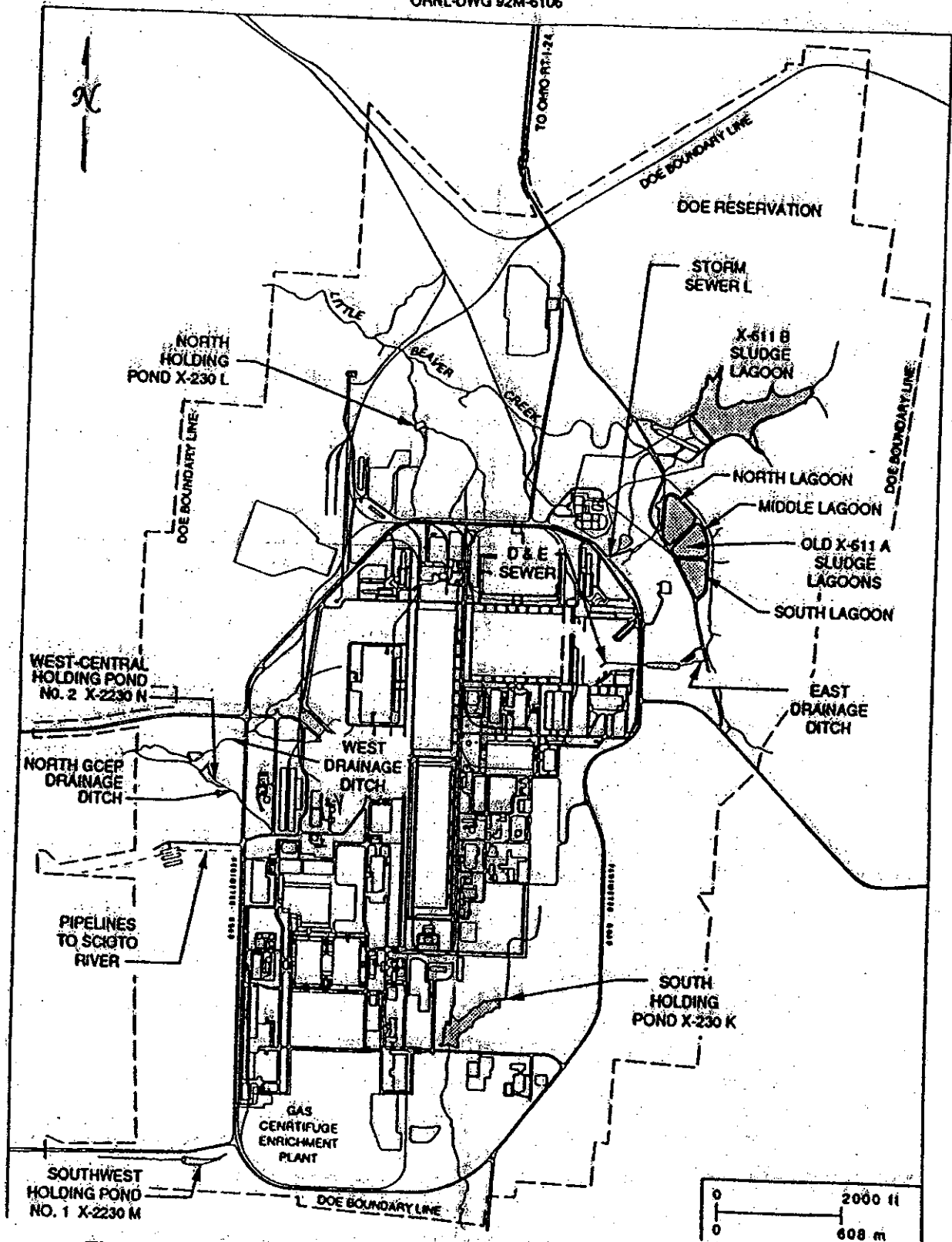


Figure 2.4-7. Ponds and lagoons at PORTS (Johnson et al. 1993, p. 3-5).

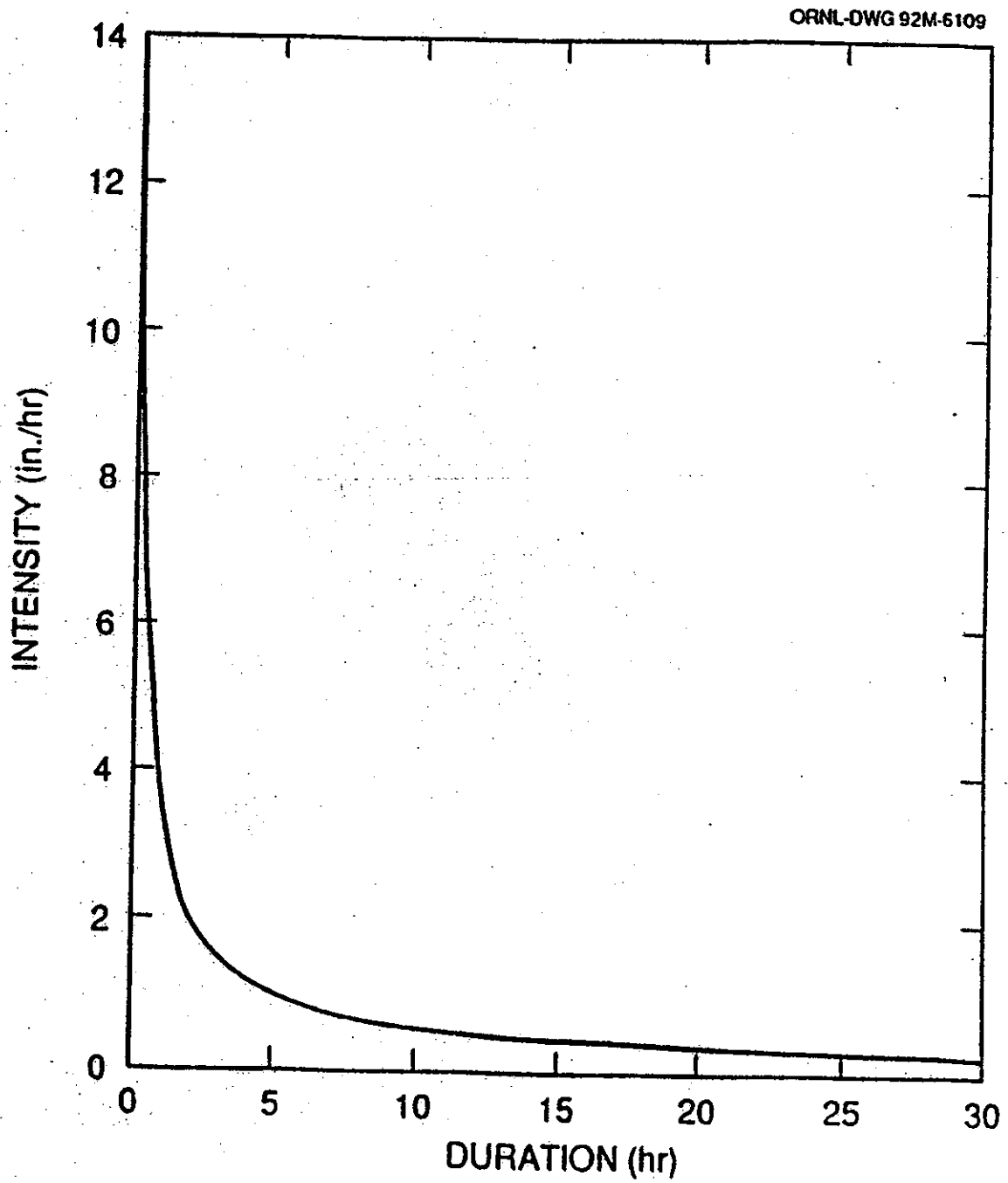


Figure 2.4-8. The 10,000-year intensity versus duration graph for PORTS (Johnson et al. 1993, p. 4-4).

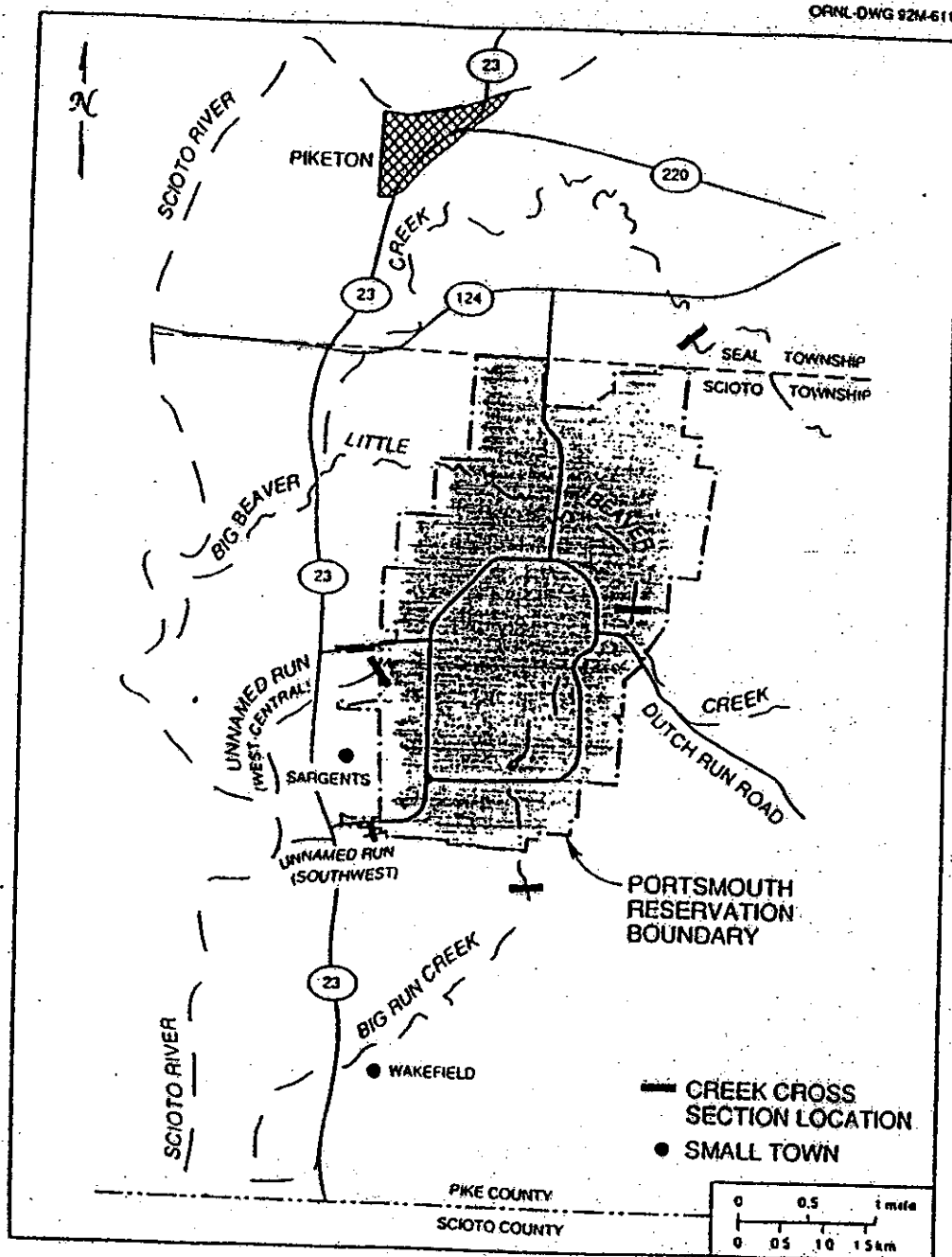


Figure 2.4-9. Locations of creek cross sections where the stage-discharge relations were evaluated (Johnson et al. 1993, p. 4-7).

## 2.5 SUBSURFACE HYDROLOGY

This section describes the subsurface hydrogeologic system in the Interior Low Plateaus region of southern Ohio in the vicinity of PORTS.

### 2.5.1 Regional and Area Characteristics

In the region surrounding PORTS in southeastern Ohio, groundwater is used for domestic and municipal drinking water supplies, irrigation, and industrial purposes. Larger demands are usually met by a combination of groundwater and surface water. A system of reservoirs is used for flood control in the Scioto River Basin, which also maintains surface water supplies during periods of low flow.

Aquifers in near-surface sand and gravel deposits adjacent to ancient or present surface drainage courses provide abundant quantities of water. Reliable quantities of groundwater from shallow bedrock aquifers are localized. While abundant quantities of satisfactory groundwater are available from deeper bedrock aquifers, depths as great as 1,000 ft make exploitation of those aquifers impractical except in the western part of the region. The quality of water from sand and gravel aquifers in the Scioto River Basin is usually classified as fair-to-excellent, while bedrock aquifers are classified as fair because of elevated iron content.

#### 2.5.1.1 Aquifers

The subsurface hydrologic system near PORTS is composed of unconsolidated Pleistocene clastic sediments of glacial and alluvial origin in river valleys and of underlying Paleozoic bedrock units. Figure 2.5-1 shows the general configuration of these valleys and bedrock units near PORTS.

The unconsolidated sediments aquifer consists of two distinct aquifers in the immediate vicinity of PORTS: the Scioto River glacial outwash aquifer and "other" alluvial aquifers, all of Quaternary Age. The Scioto River glacial outwash aquifer consists of permeable deposits of sand and gravel beneath the area adjacent to the river and occupies the ancient Newark River Valley (Figures 2.5-1 and 2.5-2). The other alluvial aquifers consist of deposits of clay and silt interbedded with lenses of sand and gravel, and they partially fill the pre-glacial drainage channels (Figure 2.5-1) and major tributaries of the Scioto River. These latter aquifers, referred to as the Gallia aquifer of the Teays Formation, are of relatively lesser importance. Because of compositional differences related to their geologic history, the Scioto and Gallia aquifers are treated separately. Table 2.5-1 relates the Scioto River outwash, Gallia hydrogeologic units, and bedrock units to the regional stratigraphic setting.

The bedrock aquifer consists of Silurian through Mississippian limestones, sandstones, and shales. The distribution and use of most of the Silurian and Devonian aquifers is limited to the western portions of the state. For example, groundwater in the Greenfield limestone is used in the area about 50 miles west of PORTS. The bedrock aquifer near PORTS consists of the Mississippian-age Bedford Shale, Berea Sandstone, Sunbury Shale, and Cuyahoga Shale in ascending order (LETC 1982, pp. 3-12).

### Scioto River Glacial Outwash Aquifer

The Scioto River Valley is underlain by glacial outwash sediments and riverbed alluvium that were deposited during the Quaternary Period. It is one of the principal aquifers in Ohio. The unit extends from the confluence of the Scioto and Ohio rivers to the headwaters of the Scioto in north-central Ohio (LETC 1982, pp. 3-17).

The glacial outwash deposits consist primarily of fine gravel and coarse sand that sometimes is interbedded with fine sand and silt and locally may contain small bodies of clay. These deposits are thickest, 70 to 80 ft, in a comparatively narrow incised bedrock channel, which in the Piketon area, generally underlies the west side of the river valley. The highly porous and permeable glacial outwash deposits are overlain by about 10 to 20 ft of fine-grained, poorly permeable river alluvium laid down by the modern Scioto River. The water table ranges generally from 10 to 15 ft below the ground surface, and the saturated thickness of the unit is about 40 to 65 ft. For the most part, the aquifer is unconfined (Norris 1983a, p. 288).

The Scioto River outwash aquifer supplies municipal, commercial, and domestic water for the area west of PORTS (USGS 1990). Yields are reported to range from 21,600 to 864,000 gal/d (Raab 1989). Large sustained yields are developed from wells ranging from 65 to 78 ft deep that are recharged by stream infiltration. Smaller yields are developed from wells sunk in thick permeable deposits of sand and gravel that occur farther away from the stream channel and are beyond the recharge influence of the Scioto River.

The Scioto River outwash aquifer is probably responsive to the stage of the present Scioto River. Water table depths in an area northwest of PORTS ranged from 10 to 29 ft below ground surface (Norris and Fiddler 1969, p. 11). Water table contours suggest aquifer discharge to the Scioto River.

### Gallia Alluvial Aquifer

The Gallia alluvial aquifer, although similar to the Scioto River outwash aquifer by being Quaternary in age, differs in its geologic history and composition. The Gallia, consisting of silty sand and gravel, is the lower member of the Teays Formation. The overlying Minford Member consists of silt and clay. Where the Sunbury Shale is absent, the Gallia Sand overlies the Berea Sandstone. Because the Gallia represents localized infilling of an ancient streambed, its areal distribution is limited.

The Gallia Sand is used locally as a source of water for municipal, commercial, and domestic purposes. It provides water only in those areas underlain by the ancient Teays River. OHDNR (1963, Plate 11) reports yields from the Gallia ranging from 7,200 to 144,000 gal/d. Similar yields, which range from 4,320 to nearly 130,000 gal/d, are reported by Raab (1989) from the eastern portion of Pike County. Yield from a municipal well for the town of Beaver, east of PORTS, is reported at 129,600 gal/d by the USGS (1990).

### Bedrock Aquifer

Data describing the bedrock aquifer in the region surrounding PORTS are generally limited to

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published maps and hydrograph data from the OHDNR, Division of Water. Such maps for Pike County (Raab 1989) and Jackson and Vinton Counties (Walker 1985) indicate that the bedrock aquifer serves only domestic needs. Flow in the Mississippian bedrock is illustrated in Figure 2.5-3.

### 2.5.1.2 Regional Groundwater Use

In the Scioto River drainage basin, which surrounds PORTS, estimated surface and groundwater withdrawal for all uses in 1960 was 399 million gallons per day. Approximately 23 percent of that withdrawal (92 million gallons per day) was derived from groundwater resources (OHDNR 1963, p. 28). Of that amount, municipal withdrawal accounted for 14 million gallons per day, and domestic use accounted for 12.2 million gallons per day. In Pike and Jackson Counties, estimated industrial demand for the year 2000 can be satisfactorily met by groundwater resources in Pike County, but not in Jackson County. Existing groundwater supplies for those counties constitute less than 1 percent of existing surface water supplies (OHDNR 1963, Table 19).

The Scioto glacial outwash aquifer serves as the principal aquifer in the region. Water from this aquifer supplies domestic, agricultural, industrial, and municipal needs. Several municipalities use the aquifer for reserve capacity. Minor alluvial aquifers (including the Gallia) supply domestic needs locally. Average yield of the Scioto outwash aquifer near PORTS is 118,080 gal/d, and average yield for minor alluvial aquifers is 30,240 gal/d (LETC 1982, Table 2.2).

Groundwater from bedrock aquifers used in those locations is removed from near-surface sand and gravel aquifers or adequate sources of surface water. Wells penetrating undifferentiated sandstone and shale bedrock aquifers in the near vicinity of PORTS yield from 144 gal/d to slightly more than 21,000 gal/d (LETC 1982, Table 2.1). With the exception of one bedrock well, which is used for industrial purposes, all bedrock wells in the vicinity of PORTS are used for domestic or agricultural purposes. The Silurian age Greenfield Limestone is used as a groundwater resource but only in the western portion of the state where it occurs at relatively shallow depths.

### 2.5.1.3 Flow in the Regional Aquifers

Many details of the subsurface hydrologic system have been described at PORTS in LETC 1982 and Geraghty and Miller 1989a, 1989b, and 1990. With respect to aquifer contamination, the two most important aquifers are the Berea Sandstone and the Gallia. The ability for environmental contaminants from PORTS facility operations and waste disposal activities to enter these aquifers and migrate off-site is the most important characteristic of the subsurface hydrologic system.

The potential for offsite contamination of regional aquifers is a function of the distribution of geologic units that might enhance cross formational flow. The vertical head profile between the Berea and the Gallia is determined by the distribution of the Sunbury Shale. Where the Sunbury is absent or very thin, an upward vertical-head profile exists from the Berea to the Gallia. Where the Sunbury is present, a vertically downward head profile exists from the Gallia to the Berea. Thus, the proximity of onsite environmental contaminants to locations exhibiting downward vertical-head profiles poses the greatest potential for offsite contamination of the Berea. This flow from the Sunbury to the Berea would occur through fractures or deeply weathered zones in the Sunbury.

Groundwater flow at PORTS is controlled by the complex interactions between the Gallia and Berea units. The flow patterns are also affected by the presence and elevation of storm sewer drainpipes and their bedding and by the reduction in recharge caused by building and paved areas. Three principal discharge areas exist for all groundwaters: (1) Little Beaver Creek to the north and east, (2) Big Run Creek to the south, and (3) two unnamed drainages to the west. Groundwater flow patterns in both the Berea and Gallia are characterized by an east-west trending groundwater divide that passes through PORTS. Other groundwater divides are also present, dividing the flow system of each unit into four sub-basins in the Gallia and three in the Berea. Figures 2.5-4 and 2.5-5 illustrate that groundwater flow directions in the Berea roughly parallel those in the Gallia (Geraghty and Miller 1989a, pp. 1-10 to 1-11).

While contamination of the Berea aquifer from onsite activities is possible, due to the downward vertical-head profile from the Gallia, offsite monitoring has not detected contaminant concentrations above background levels (Kornegay et al. 1990, p. 67). Additionally, dissolved solids exceeding 10,000 ppm within about 5 miles downgradient from PORTS make it unlikely that significant portions of the Berea drinking water resource would be adversely affected.

Precipitation is the primary source of recharge of these aquifers. Recharge at PORTS is estimated at between 2.3 and 11.7 in./year (Geraghty & Miller 1989b, pp. 2-17 and 2-19). Infiltration reaches the water table and moves laterally to areas of discharge or vertically to adjacent aquifers. The Gallia aquifer near or adjacent to surface drainage ways are likely in active communication with the surface water.

### 2.5.2 Site Characteristics

PORTS sits in a mile-wide former river valley (Portsmouth River Valley) surrounded by farmland and wooded hills with generally less than 100 ft of relief. The main plant area has a nominal elevation of 670 ft above mean sea level (AMSL) about 130 ft above the stage of the Scioto River, which lies about 2.5 miles to the west. The Scioto River and its tributaries receive essentially all of the surface water and groundwater discharge at PORTS.

Geologic units controlling groundwater flow beneath PORTS are, in descending order, the Minford and Gallia unconsolidated units of the Quaternary age, and the Sunbury, Berea, and Bedford bedrock units of the Mississippian age (Table 2.5-1). The Mississippian Cuyahoga shale, the youngest bedrock unit in the area, forms the hills east and west of the main plant site (Figure 2.5-1). Also present in some places is up to 20 ft of artificial fill, which is predominantly Minford silt and clay.

The main groundwater flow system beneath PORTS is the Gallia sand and the lower unit of the Minford, the Minford silt. The Gallia is composed of silty to clayey sand and gravel, with silt and clay content amounting to about 30 percent (LETC 1978, p. 7-6). It has an average thickness of 3.4 ft and is not laterally continuous beneath PORTS (Geraghty & Miller 1989a, p. 2-3). The Minford averages 23.9 ft in thickness at PORTS, grading from clay and silty clay near the surface to predominantly silt at the base. The lower silty unit averages 7.6 ft in thickness and constitutes about 33 percent of the Minford. The Gallia sand and the lower Minford silt form the uppermost, unconfined aquifer (the Gallia aquifer) with a combined thickness of about 11 ft (Figure 2.5-6). The bottom of the Gallia aquifer has an elevation ranging from 630 to 640 ft AMSL in the plant area.

The Gallia aquifer is partly surrounded by the Cuyahoga shale, which lies in the wooded hills around PORTS (Figure 2.5-1) and is in various stages of decomposition. The decomposed state of the Cuyahoga can be identified by its gray-green color, clayey texture, thin bedding, and the presence of small flat remnant sandstone pieces. The unweathered rock is a moderately hard, gray to gray-green, thinly laminated shale with laminated or very thin layers of sandstone (LETC 1978, p. 7-8).

Both the Gallia aquifer and the Cuyahoga shale are underlain by the Sunbury shale in unweathered and various decomposition stages. The Sunbury has a thickness ranging from 0 to 20 ft with an average of about 10 ft over much of the site (Geraghty & Miller 1989a, p. 2-3). Beneath the west and northwest side of PORTS, the Sunbury is thin or absent; beneath the southeast half of PORTS, the Sunbury is present and thickens toward the east (Geraghty & Miller 1992, p. 8). The unweathered Sunbury is hard to moderately hard black, fissile, and highly carbonaceous. It commonly contains pyrite and marcasite nodules and layers. In advanced stage of weathering, the Sunbury is a gray, laminated, highly plastic clay (LETC 1978, p. 7-8).

The Sunbury separates the Gallia aquifer from the underlying confined aquifer, the Berea sandstone. The Berea is largely unweathered and has an almost uniform thickness of about 30 ft except over a small portion of the site where a few feet may have been removed by the former Portsmouth River. It is hard to very hard, thick bedded, and fine grained. The Berea contains occasional shale laminations, swirls, or blebs in the top 20 ft and many shale laminations and interbeds in the lower 10 ft, with shale layers commonly weathered partially or completely to clay (LETC 1978, p. 7-9). Where the Sunbury is absent or thin, the Berea aquifer and the overlying Gallia aquifer act essentially as one unit.

About 100 ft of Bedford shale underlies the Berea aquifer over the entire PORTS site. The lower 10 ft of the Berea is very similar to the underlying Bedford shale (Geraghty & Miller 1989a, p. 2-4; Battelle 1981, p. 36). The Bedford is composed of thinly bedded shale with interbeds and laminations of hard gray fine-grained sandstone and siltstone. Sandstone is occasionally calcareous and evenly distributed through the shale and amounts to about one-third to one-half of the Bedford formation (LETC 1978, p. 7-9).

#### **2.5.2.1 Aquifers Beneath the Site**

The Gallia exhibits the highest hydraulic conductivity of all aquifers on the PORTS site. Hydraulic conductivity values range from 0.11 to 150 ft/d, with a mean of 3.4 ft/d (Geraghty & Miller 1989a, pp. 1-10). Groundwater flow directions in the Gallia are roughly from the center of the PORTS site toward the surrounding low-lying surface water drainage system. The ultimate discharge area for most groundwater is Little Beaver Creek to the north and east, Big Run Creek to the south, and two unnamed drainages to the west.

#### **2.5.2.2 Aquifer Properties**

At the PORTS site, the Berea Sandstone exhibits little spatial variation in hydraulic properties. The site-wide mean hydraulic conductivity for the Berea is 0.16 ft/d (Geraghty & Miller 1989a, pp. 1-10). The highest hydraulic conductivity in the Berea was measured as 0.35 ft/d at the X-616 area, where

the unit has been slightly eroded and may be slightly weathered; the lowest hydraulic conductivity was measured as 0.1 ft/d at both X-231B and X-701B.

Groundwater elevations in the Berea Sandstone are determined by local geologic conditions. Measurements at PORTS between August 1988 and September 1989 indicate a mean water elevation of 646.15 ft MSL with a standard deviation of 0.92 ft (Geraghty & Miller 1990, Table 2.3). A generally downward vertical gradient occurs between the Berea and overlying aquifer when overlain by the Sunbury Shale, which acts as an effective confining unit. Where the Sunbury is absent or very thin, an upward vertical gradient exists between the Berea and overlying aquifer. Groundwater flow in the Berea is expected to be similar to those of the Gallia except in the eastern part of the site, where the directions are generally toward the east and southeast.

### Hydraulic Conductivity

The most conductive units beneath PORTS are the Gallia sand and the Berea sandstone (Geraghty & Miller 1989a, p. 2-10). The Gallia sand has a mean hydraulic conductivity of 3.4 ft/d and a range of 0.11 to 150 ft/d. The Berea sandstone has a mean hydraulic conductivity of 0.16 ft/d and a range of 0.0045 to 15 ft/d. These estimated values from single-well tests, together with hydraulic conductivity values obtained by LETC (1978) using other methods for various formations, are listed in Table 2.5-2.

Table 2.5-3 summarizes the hydraulic conductivities used in the Geraghty & Miller PORTS groundwater model (Geraghty & Miller 1989a, Table 2.1). Four values were used for the Gallia aquifer and two for the Berea aquifer. The vertical hydraulic conductivity for the Sunbury shale is an average value estimated from the vertical leakance values for layers ranging from 2 ft to 20 ft thick. Table 2.5-4 summarizes the hydraulic parameters used in the Geraghty & Miller Quadrant II RFI groundwater model (Geraghty & Miller 1992, Table 5.4).

### Storage Coefficient

The storage coefficient of the Gallia sand, which may be in underconfined or unconfined condition depending on the thickness of overlying Minford clay, was found to be highly variable with a mean value of 0.016 and a range of 0.00011 to 0.41 (Geraghty & Miller 1989a, p. 2-11 and App. B). No corresponding statistical values for the Minford or Berea were reported, even though some similar data are available in that same source. An effective porosity of 20 percent was assumed for the unconsolidated Gallia aquifer in some particle tracking calculations based on the Geraghty & Miller groundwater flow model (p. 5-3). An effective porosity of 1 percent was assumed for the Berea in a velocity estimation (Geraghty & Miller 1989b, p. 2-14).

### Recharge

Recharge from precipitation has been estimated to be 8.9 in./year using the 1985 data and the Thornthwaite method (Geraghty & Miller 1989a, p. 2-12 and Table 2.2). This corresponds to about 25 percent of the total precipitation of 35.78 in. that year. In general, the estimated annual recharge rates vary from 3.3 to 11.7 in./year. In the calibrated groundwater flow model for PORTS by Geraghty & Miller (App. A), three recharge values were used: 6.0 in./year for Minford clay, 1.2 in./year for

Cuyahoga shale, and 0 in./year for paved area. Recharge values used in the Geraghty & Miller Quadrant II RFI groundwater model (Geraghty & Miller 1992, Table 5.4) are summarized in Table 2.5-5.

Little Beaver Creek to the north and east, Big Run Creek to the southeast, and the two unnamed tributaries to the west control groundwater flow in the Gallia and Berea aquifers by acting as local recharge or discharge areas. In some places, the large-diameter storm drain segments are partially below the elevation of the Gallia water table (Geraghty & Miller 1989a, p. 2-13). These drains and surrounding gravel beddings may act as groundwater interceptors in the Gallia flow system.

### 2.5.2.3 Groundwater Flow

The main groundwater flow unit beneath PORTS is the Gallia aquifer formed by the Gallia sand and the Minford silt, with a combined average thickness of about 11 ft (Figure 2.5-6). The hydraulic conductivity of this aquifer is not considered as high, but the surrounding Cuyahoga shale and underlying Sunbury shale and Berea sandstone have even lower conductivities and form less important groundwater flow units (Geraghty & Miller 1989a, p. 2-10 and 7-10). In general, the Gallia aquifer beneath the main plant area receives recharge through infiltration of rainfall and discharges water to surrounding low-lying areas through openings formed by missing Cuyahoga shale. Figure 2.5-7 shows the configuration of these openings around the main plant area. As shown from this figure and also the bedrock surface plot shown in Figure 2.5-8, one narrow opening is between the X-701B area (E10,400 ft, N10,700 ft) and Little Beaver Creek to the east. Two wide openings exist, one near the northern perimeter road toward Little Beaver Creek and the other near the southern perimeter road (Figure 2.5-7). Discharges, in the form of groundwater, are likely to occur from the main plant area through these openings. Other openings that are not easily seen from the bedrock surface plot are associated with Big Run Creek to the south and the two unnamed tributaries to the west. Discharges through these openings are likely first in the form of groundwater and then as surface water in the creeks. All these discharge routes can be potential pathways for PORTS contaminants to reach areas outside the plant and ultimately the Scioto River.

Regional flow in the Berea is generally to the southeast, in the direction of structural dip. Locally, the flow direction is affected by Big Run Creek, Little Beaver Creek, and the west and southwest drainages (Geraghty & Miller 1992, p. 9). For example, flow in the northern part of the site turns somewhat northward due to the influence of Little Beaver Creek. In areas where the Sunbury is absent, the Berea and the overlying Gallia become hydraulically connected.

Figures 2.5-4 and 2.5-5 illustrate the potentiometric surface in the Gallia aquifer and in the Berea aquifer, respectively (Geraghty & Miller 1989a, Figures 2.16 and 2.17). Groundwater flow directions in both aquifers are influenced by the presence of Little Beaver Creek, Big Run Creek, and the two unnamed tributaries. At many places, the two groundwater flow systems are roughly parallel, but at some places, for example near the northern perimeter road, they are quite different. As indicated in Figure 2.5-4, groundwater divides separate the Gallia flow system into several flow cells. These flow cells have been used as the basis for the separation of the PORTS site into four RFI quadrants (Geraghty & Miller 1992, p. 8).

In general, large head differences exist between the Gallia and the Berea because the Sunbury

shale presents an effective barrier that restricts the vertical communication between the two aquifers (Geraghty & Miller 1989b, Executive Summary). The Sunbury is approximately 5 ft thick over much of the X-749 Mixed Waste Landfill area, and the observed heads in the Gallia are approximately 10 to 15 ft higher than those in the Berea. Near the X-231B Oil Biodegradation Plots, the Sunbury is 10 to 12 ft thick and there is a 8 to 10 ft head difference. The Sunbury Shale is absent under the X-616 Chromium Sludge Surface Impoundments area. Beneath X-616, the Gallia and the Berea essentially act as one unit.

In 1988, a groundwater quality assessment (GWQA) investigation was implemented at four RCRA regulated facilities at PORTS: the X-701B Holding Pond, X-749 Mixed Waste Landfill, X-231B Land Treatment Area, and X-616 Chromium Sludge Surface Impoundments (Geraghty & Miller 1989b, p. ix). The results of this investigation indicate that the Gallia exhibits significant contamination with trichloroethylene (TCE) and other compounds at X-231B, X-749, and X-701B. In the underlying Berea sandstone, only very small concentrations of contaminants at or near the analytical detection limits were detected. No plume was found beneath the X-616 RCRA unit. In general, only small concentrations of radioactive contaminants were found.

Offsite monitoring of the sanitary water systems of local residents near PORTS began in 1979, and analysis for the presence of organic compounds was added in 1986 (Kornegay et al. 1991, p. 83). The monitoring is conducted semiannually on springs and private wells near PORTS including parameters such as uranium, technetium, total alpha, and total beta. To date, the monitored parameters have not been detected above background levels in any of the sampling locations.

**Table 2.5-1. Regional stratigraphic and hydrogeologic subdivisions (Lee, 1991, p. 10).**

ERA	System	Series	Formation or unit	Hydrogeologic Unit
Cenozoic	Quaternary	Pleistocene	Teays Scioto River Outwash Minford Member Gallia Member	Scioto River
	Mississippian		Cuyahoga Sunbury Shale Berea Sandstone Bedford Shale	Gallia
Paleozoic	Devonian	Upper	Ohio Shale	Bedrock

*Source:* Lee 1991, p. 10.

**Table 2.5-2. Summary of mean hydraulic conductivity data for various formations**

Formation	Minimum (ft/d)	Maximum (ft/d)	Mean (ft/d)	Source
Minford clay	0.000030	0.0019	0.00049	(a)
Minford silt	0.00072	0.016	0.0055	(b)
	0.0050	0.017	0.010	(c)
			0.62	(d)
Gallia	0.11	150.	3.4	(e)
	0.12	0.39	0.24	(f)
Berea	0.0045	15.	0.16	(e)
Bedford	0.020	0.17	0.062	(g)

a. Based on 18 triaxial tests (LETC 1978, Table 7-1).

b. Based on 20 triaxial tests (LETC 1978, Table 7-1).

c. Based on five constant head tests (LETC 1978, Table 7-1).

d. Single-well slug test (Geraghty & Miller 1989a, p. 2-11 and App. B)

e. Single-well test analytical results (Geraghty & Miller 1989a, p. 2-10 and App. B)

f. Based on three constant head tests (LETC 1978, Table 7-1).

g. Based on 13 packer injection tests (LETC 1978, Table 7-2).

**Table 2.5-3. Summary of hydraulic conductivities used in the  
Geraghty & Miller PORTS groundwater flow model.**

Formation	Conductivity (horizontal) (ft/d)	Conductivity (vertical) (ft/d)
Cuyahoga	0.46	-
Gallia/Minford	0.17	-
	2.0	-
	5.8	-
	14.0	-
Sunbury (average)	-	0.000554
Berea	30.	-
	170.	-
Bedford	33.	-

*Source:* Geraghty & Miller 1989a, Table 2.1.

**Table 2.5-4. Hydraulic conductivity values used in the calibrated  
Quadrant II RFI groundwater model.**

Geologic Zone	Zone No.	Horizontal (ft/d)	Vertical (ft/d)
Minford	1	0.5	5.0E-5
	2	0.5	5.0E-5
	3	0.5	0.1
	8	0.5	0.2
Gallia Sand	4	100.	7.5
	5	11.7	1.5
	6	48.7	5.0
Sunbury shale	7	3.0E-4	3.0E-5
Berea	9	3.3	0.3

*Source:* Geraghty & Miller 1992, Table 5.4.

**Table 2.5-5. Recharge values used in the Geraghty & Miller  
Quadrant II RFI groundwater model.**

Geologic Unit	Zone No.	Recharge (in./yr)
Minford	1	3.38
	2	0.25
	3	0.0
Gallia sand	4	26.28
	5	15.33

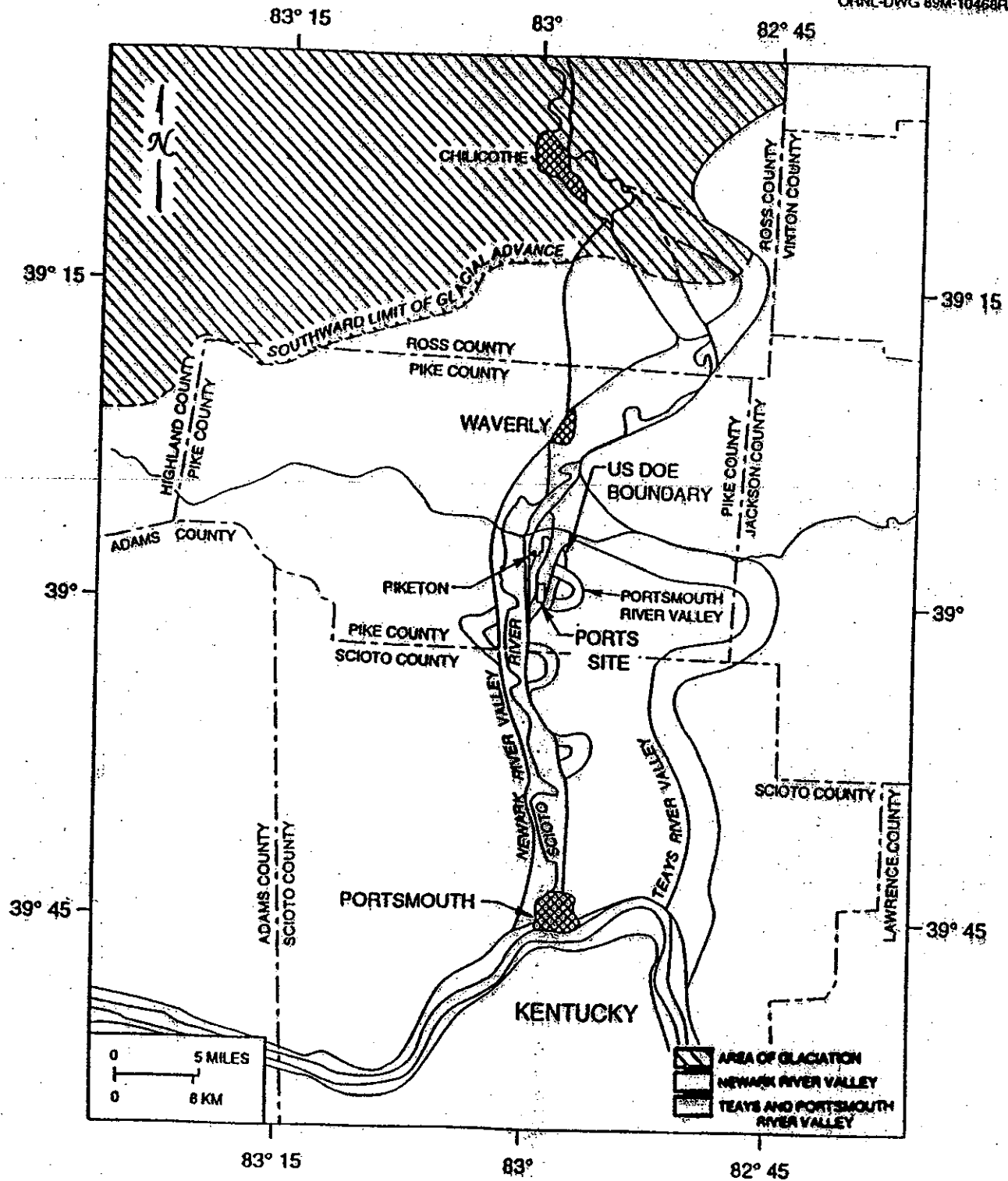


Figure 2.5-1. Location of the ancient Newark (modern Scioto) and Teays River valleys in the PORTS vicinity (Lee 1991, p. 12).

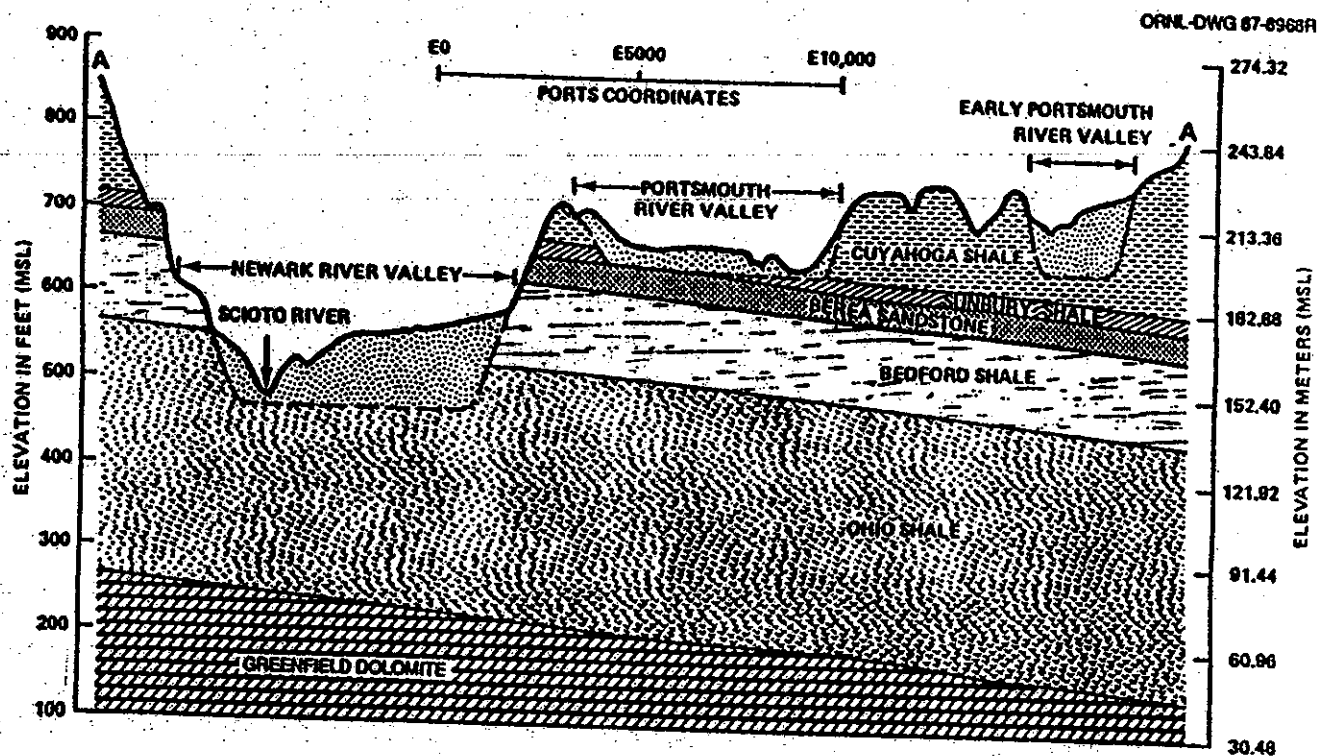


Figure 2.5-2. Geologic cross section in the PORTS vicinity (Lee 1991, p. 9).

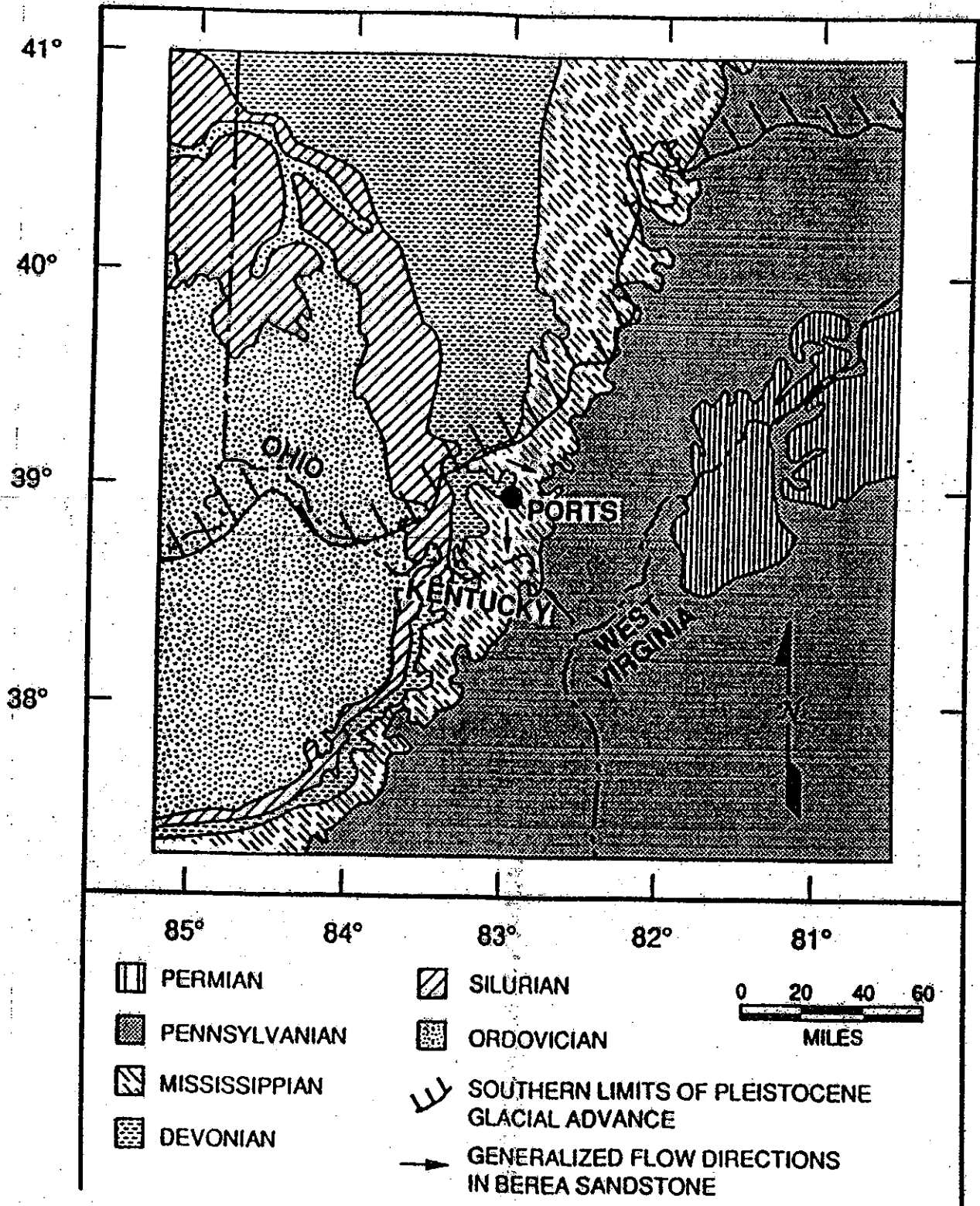


Figure 2.5-3. Geologic map of the PORTS region and generalized groundwater flow directions in Mississippian bedrock near PORTS (Lee 1991, p. 11).

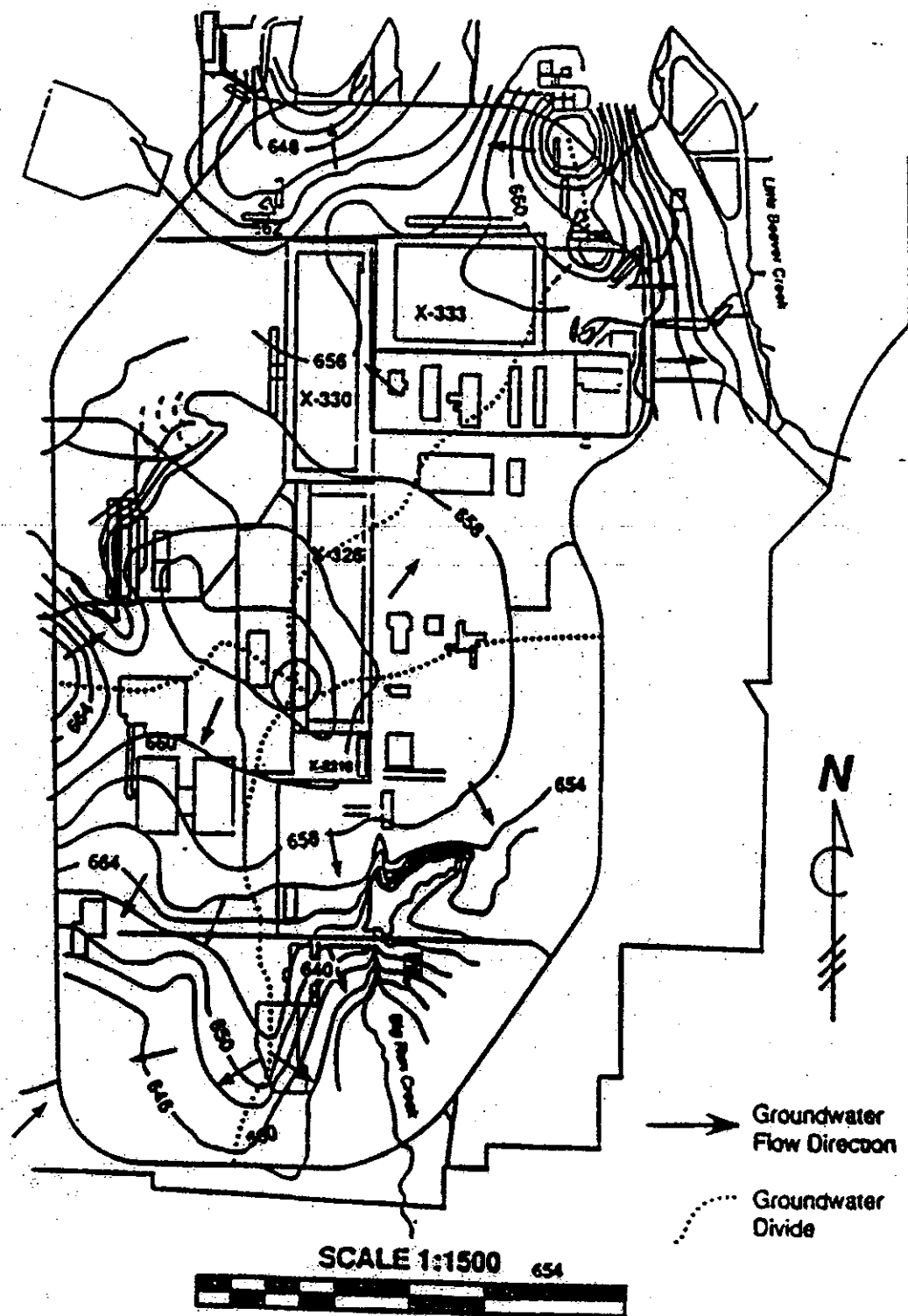


Figure 2.5-4. Potentiometric surface of the Gallia aquifer for December 12, 1988.

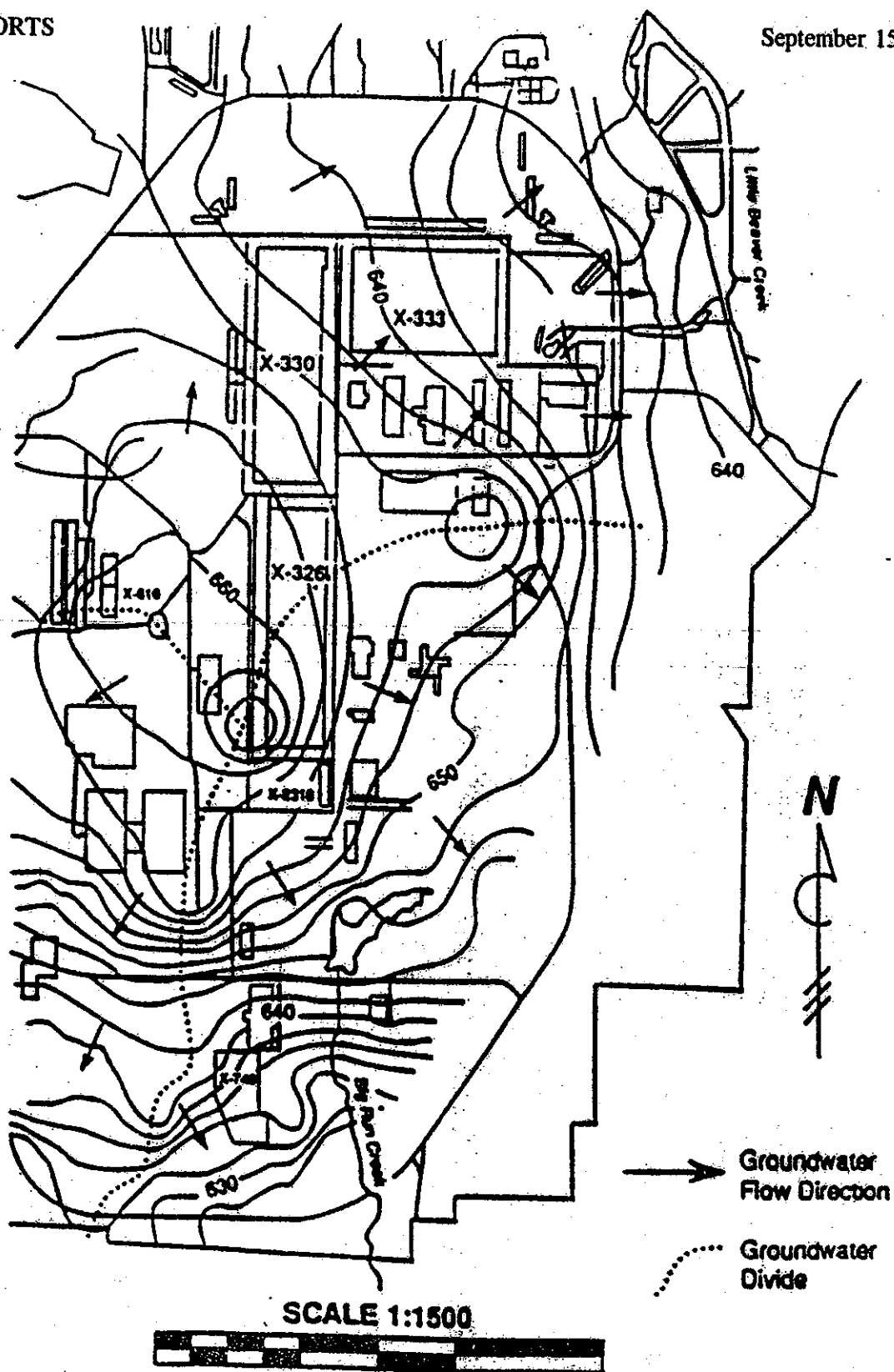


Figure 2.5-5. Potentiometric surface of the Berea aquifer for December 12, 1988.

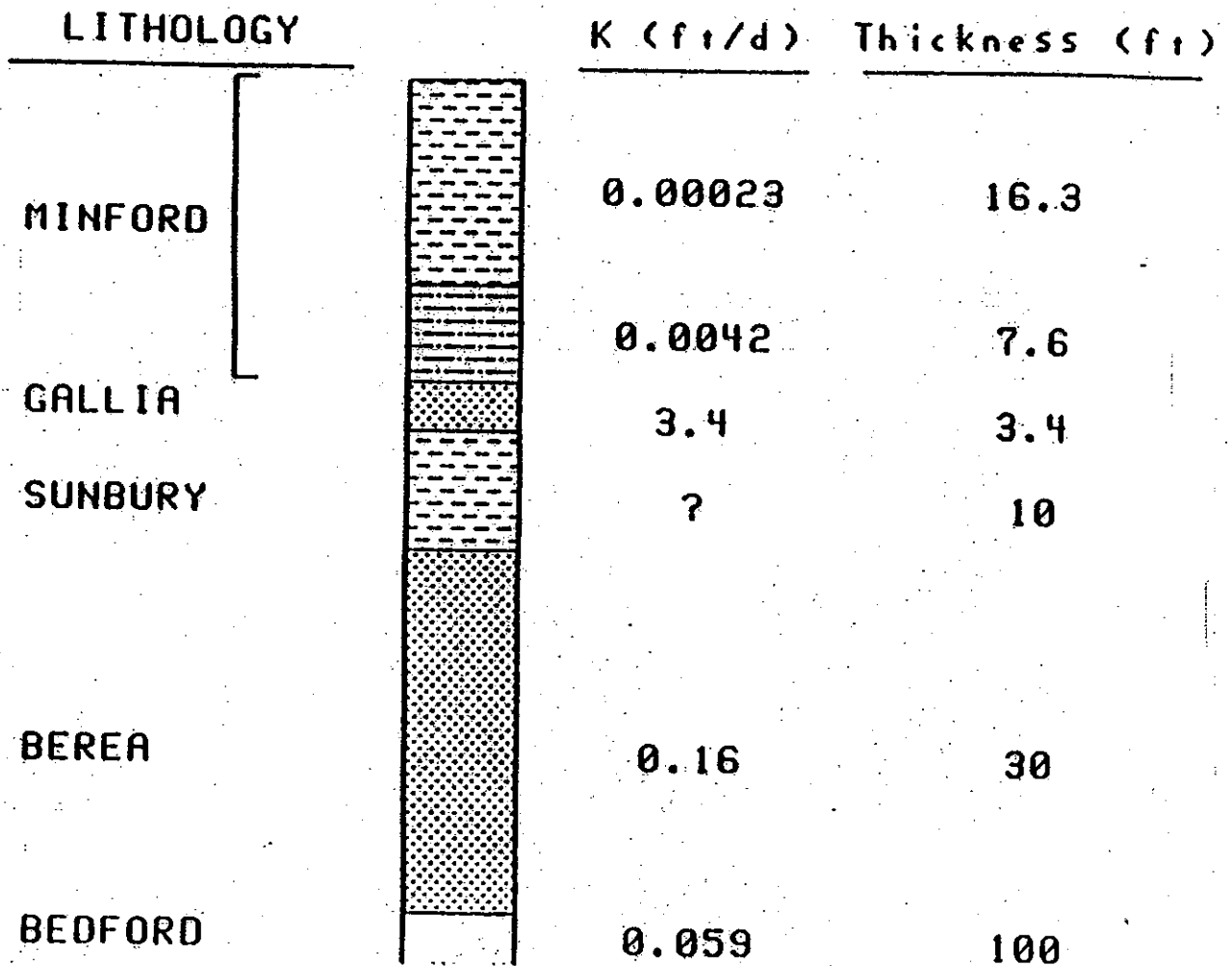


Figure 2.5-6. Geologic column at PORTS (Geraghty & Miller, 1989a, Fig. 2.4).

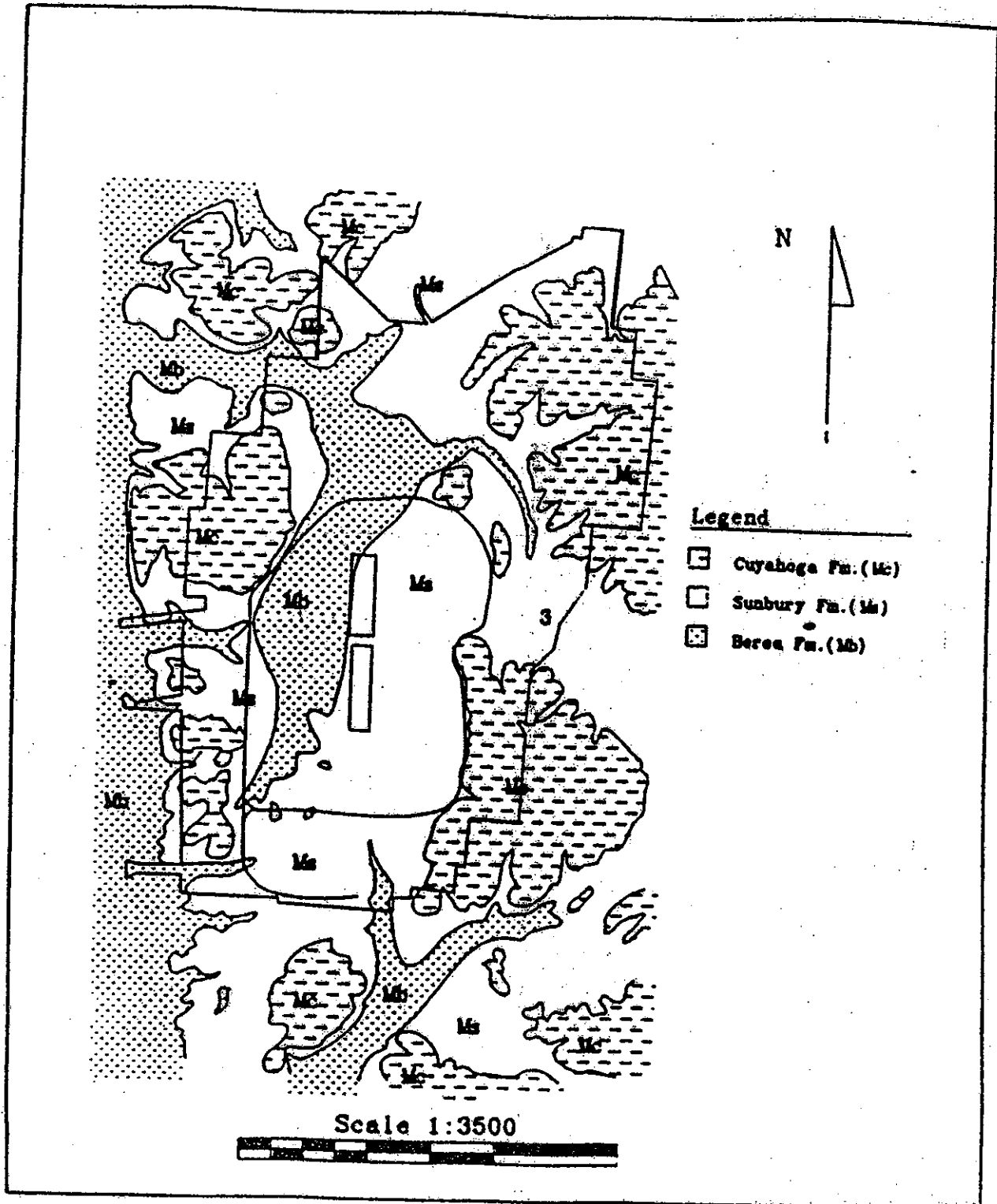


Figure 2.5-7. Hydrogeologic map of PORTS showing approximate outcrop/subcrop patterns of Mississippian bedrock (Geraghty & Miller 1989b, Fig. 1.1).

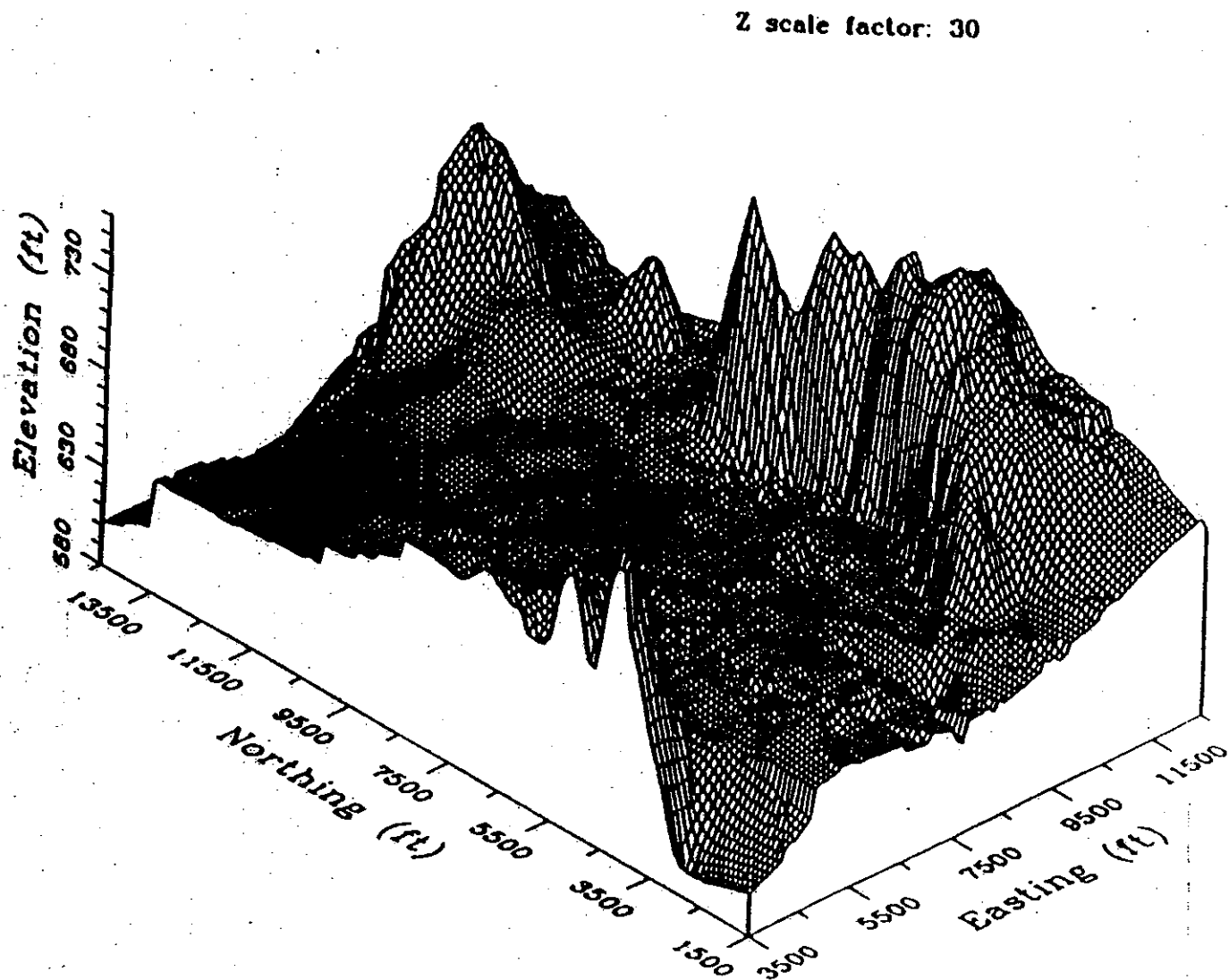


Figure 2.5-8. Bedrock surface beneath PORTS showing the narrow opening between the X-701B area and Little Beaver Creek to the east.

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## **2.6 GEOLOGY AND SEISMOLOGY**

This section describes the geology and seismology, vibratory ground motion, surface faulting, and geologic structure at PORTS. Regional and site-specific physiography, stratigraphy, geologic history, structural setting, and engineering geology are described. Information on earthquake history and seismic hazards analysis is provided as well.

### **2.6.1 Basic Geologic and Seismic Information**

#### **2.6.1.1 Regional Physiography**

PORTS is located within the Interior Low Plateaus physiographic province, about 20 miles south of its northwestern edge. It is bordered on the north and west by the Central Lowlands province and on the south and east by the Appalachian Plateaus province. Figure 2.6-1 shows the relationship of the site to the physiographic provinces within a 200-mile radius of the site (Fenneman and Johnson 1946).

The Appalachian Plateaus province is composed of mature upland areas that have been dissected by erosion and now exhibit moderate to strong relief. This province is underlain by gently dipping Mississippian, Pennsylvanian, and Permian Age shale and sandstone. Both the adjacent Central Lowlands and the Interior Low Plateaus provinces are underlain by relatively flat-lying Paleozoic Age limestone and shale. The Interior Low Plateaus (Lexington Plain section) to the south and west is a mature to old plain of low relief, whereas the Central Lowlands (Till Plains section) to the north and west is a young feature of low relief. The Valley and Ridge (Tennessee section) is underlain by thrust-faulted Paleozoic limestone, dolostone, shale, and sandstone of moderate relief.

Portions of the Appalachian Plateaus, Central Lowlands, and Interior Low Plateaus provinces have been glaciated, but the site is south of the region covered by Pleistocene glaciation. However, alluvium and transported glacial sediments form a surface veneer in the mile-wide, broad valley where PORTS is located. The surrounding hills have been maturely dissected by erosion, exposing the underlying, nearly flat-lying shale and sandstone of Mississippian and Pennsylvanian Age. Ground elevations within the plant generally range from about 660 ft MSL to 680 ft MSL, although the ground rises to about 700 ft MSL at the base of hills that border the Perimeter Road; the surrounding hills extend up to about 1,200 ft MSL.

#### **2.6.1.2 Regional Geologic History and Geology**

The site is located near the western edge of the Appalachian Basin, a generally circular basin in which a thick column of Paleozoic sediments accumulated (Figure 2.6-2). The thickness of these Paleozoic Age rocks increases markedly south and east of the site (where several tens of thousands of feet of relatively undeformed Early Paleozoic sediments occur), but the nearest basement well (Ohio Permit No. 212—about 30 miles southeast of the site) encountered only about 5,600 ft of Paleozoic sediments overlying Precambrian bedrock. The Appalachian Basin is separated from the Illinois Basin to the west by the Cincinnati Arch and the Kankakee Arch and from the Michigan Basin by the Indiana-Ohio Platform and the Findlay Arch. Both the Michigan Basin and the Illinois Basin are semicircular basins that contain thousands of feet of relatively undeformed Early to Late Paleozoic clastic sediments. The Cincinnati and Kankakee Arches are composed of Early Paleozoic limestone and shale overlying a topographic high of Precambrian bedrock. Figure 2.6-3

depicts the regional geology. A northwest to southeast trending regional geologic profile is presented in Figure 2.6-4.

Ancient rift zones are significant in eastern North America because they are potential sites for reactivation in the contemporary stress field (Zoback 1992). The Rome trough is the nearest known ancient rift zone to the Portsmouth site. This structure was active as a rift zone in late Precambrian and Cambrian times. The Rome trough trends east-west through east central Kentucky. It terminates on the west against the Lexington fault in central Kentucky and is bounded on the north and south by the Kentucky River fault system and the Rock Castle fault system, respectively. The Rome trough turns toward the northeast in western West Virginia and continues on into western Pennsylvania and New York. More than 10,000 ft of Cambrian strata were deposited in most of the Rome trough during active rifting. Younger Paleozoic strata are much thinner in the Rome trough, which suggests that the most active rifting had run its course by the end of Cambrian time.

Continental glaciation covered about two-thirds of Ohio, with the glacier scouring rock and soil from the land surface to the north and depositing materials under it and at its southern edge. The last ice sheet receded from Ohio about 15,000 years ago, but it and its predecessors never advanced to cover the area of the site.

The presence of continental glaciation to the immediate north during the Quaternary Epoch interrupted and blocked drainage of pre-Pleistocene northward and westward flowing rivers and formed glacial lakes south of the glaciers. Consequently, sediment from the inflowing ancient Teays River and tributaries such as the Portsmouth River and sediment carried by glacial meltwater from the north were deposited in the river valleys. In the Portsmouth Valley, these sediments were deposited up to about 860 ft MSL. Since the retreat of the last glacier, the area has eroded and most of the glacial sediments have been removed. The remaining glacial sediments consist of about 3 ft of Portsmouth River alluvium overlain by about 23 ft of proglacial lakebed sediments (lacustrine deposits of the Teays Formation) consisting of silt and clay.

#### 2.6.1.3 Regional Stratigraphy and Lithology

Much of the region consists of undeformed or only slightly deformed bedrock contained in the Appalachian, Illinois, and Michigan Basins. The Paleozoic rocks of the Appalachian Plateaus and the bordering Interior Low Plateau and Central Lowlands within 50 miles of the site are relatively undeformed and dip to the southeast at about 30 ft/mile. A broad arch of early Paleozoic Age (i.e., the Waverly Arch) may have been formed by Cambrian and Ordovician rocks beneath the site. Calvert (1968) questions the existence of the Waverly arch because Ordovician mountain building (orogenic movements) activity is unknown, but a postulated Paleozoic fault trending north-south in central Ohio may explain such an arch (ERCE 1990).

The nearest mapped surface tectonic features are high-angle, normal faults of the Kentucky River fault system, located about 60 miles to the south, and the Lexington fault system, about 50 miles to the southwest. These two fault systems form the north and west boundaries of the Rome trough, respectively. Both fault systems offset Ordovician to Pennsylvanian strata, which suggests sporadic activity in the Rome trough throughout Paleozoic time. Based on documents that preceded the work of Vanarsdale (1986), no Quaternary strata have been offset, indicating that these faults have not been active in the past 1.6 million years.

More recently, Vanarsdale (1986) mapped subtle Pliocene/Pleistocene displacements (1 to 2 ft) and possible Holocene warping along branches of the Kentucky River fault system. These displacements are both

strike slip and reverse slip and are compatible with the contemporary stress field of Zoback (1992).

To the south and west, a few normal, high-angle faults in Indiana have been dated to be at least Pliocene (i.e., greater than 1.6 million years old) age (Ault et al. 1985).

Further to the southeast (i.e., about 150 miles, Paleozoic rocks at the margin of the Appalachian Plateaus and within the Appalachian Valley and Ridge province are broken by numerous thrust faults. This faulting is generally accepted as having occurred during the late Paleozoic or early Mesozoic. Because these are low-angle thrust faults, they do not penetrate deep into the earth's crust and probably react passively to the contemporary stress field.

Clastic rocks (i.e., sandstone and shale) underlie the soil at the site and these rock types extend downward to a depth of about 500 ft. Soluble bedrock (i.e., limestone and dolostone) is not present within 500 ft of the ground surface, although it crops out several miles to the north and west.

There are areas of surface karst development and caverns in the adjacent physiographic provinces, but none occur in the Appalachian Plateaus province near the site. Soluble bedrock is not present within 500 ft of the ground surface at the site, and there is a very low probability of solution of the bedrock producing caverns or karst terrain at the site.

The plant is situated in the middle of a relatively flat, broad, river valley, and almost all slopes that exist within the plant have inclinations of less than 3 horizontal to 1 vertical (3H:1V). Landslides occur only in areas of more steeply sloping ground such as the adjacent hills; because of the relatively flat slopes, there is only a very remote possibility of slope failures in the plant area due to heavy precipitation and/or ground shaking. However, there is a higher possibility of surficial (i.e., topsoil) slope failures in steeper cut and fill slopes outside the perimeter road and in the adjacent hills during periods of intense rainfall and/or ground shaking.

Coal is present only in the Pennsylvanian rocks of the region to the east at higher elevations. Further, there are no known underground mines developed for extracting aggregate or other mineral resources in the area that would affect the performance of the facility.

A modest, spotty production of natural gas from the underlying Ohio shale occurs within a 5-mile radius of the plant. The nearest known producing well is about 3,000 ft northeast of the site; it is currently producing about 50,000 ft<sup>3</sup> of gas per day (50 MD). Four other natural gas wells are located 3 to 5 miles to the southeast; production from them ranges from 5 MD to 40 MD. There are no reports of subsidence due to hydrocarbon extraction in southern Ohio.

The area is not known to be undergoing regional warping, but a very modest amount of rebound due to glacial unloading may still be occurring.

## **2.6.2 Site Physiography and Geology**

### **2.6.2.1 Site Physiography**

The plant is located within a broad, flat valley that was (1) primarily developed by long-term erosion

of the shale and sandstone that underlies the Interior Low Plateaus physiographic province, (2) subsequently modified by partial filling by glacial and alluvial sediments, and (3) later subjected to erosion. The prolonged erosion since the end of the Permian Period (since 245 Ma) has produced the dominant topography. Ground elevations within the site range from about 620 ft MSL to 700 ft MSL; the highest elevations occur along the eastern and northwestern sides of the plant site where the Perimeter Road skirts the base of low hills. The nearby Scioto River (at about elevation 510 ft MSL) is the lowest elevation within 5 miles. The highest elevations (1,200 ft MSL) occur in a few of the surrounding maturely dissected hills.

Prior to construction of the plant, the area was farmland that formed a portion of the watershed for the nearby Scioto River. A drainage divide (about elevation 675 ft MSL) was at about plant coordinate N 9000, which separated gullies and streams flowing to the north from those flowing west and south. Generally, site preparation and grading involved only minor surface modification. With the exception of a few drainage features (swales) that required as much as 20 ft of fill, most of the area developed was cut less than 10 ft and filled less than 12 ft. Elevations within the Perimeter Road now range from 620 ft MSL to 702 ft MSL, with most of the plant area at about 670 ft MSL. Within the Perimeter Road is one slope about 10 ft high that has a slope of 2H:1V; other slopes have inclinations of 3H:1V or less.

#### 2.6.2.2 Site Geologic History

Erosion of the region between the Triassic and Neogene Periods has produced the general shape of the region and the site. The regional drainage established during this period was the Teays River System, which originated in North Carolina and flowed generally west and north through Ohio, Indiana, and Illinois.

The glaciation, beginning about 1.6 Ma and extending to about 10,000 years ago, has had a marked effect on the geology of the site. Obstruction of the Teays River system (including the Portsmouth River and other drainage ways) by the advancing glacier created a series of finger lakes in the area (glacial Lake Tight). Sediments were deposited in these finger lakes from the inflowing rivers and from glacial meltwater, creating lacustrine (lake) deposits (Gallia sand and Minford clay) of the Teays Formation discussed earlier. The age of the Teays Formation is thought to range from 0.7 Ma to 1.5 Ma. As Lake Tight continued to be filled with glacial meltwater containing sediment, a new drainage path was finally established. The new drainage path was via the ancient Newark River; this river joined the ancestral Ohio River by flowing south along the approximate route of the existing Scioto River Valley. During the drainage to the south, significant erosion of glacial sediments occurred in valleys such as the one carved by the ancient Portsmouth River; an estimated 200 ft of sediment (i.e., from elevation 860 ft MSL to 660 ft MSL) was eroded. During the past 10,000 years, the site has been mostly undergoing erosion, with local streams depositing alluvium in response to flooding.

#### 2.6.2.3 Site Geology and Stratigraphy

Aside from roadways and other ancillary structures outside the Perimeter Road, the plant is located within the valley eroded into the bedrock by the ancient Portsmouth River and later filled by glacial Lake Tight sediments. Except for a few low hills that extend into the plant site between N 5800 and N 10000, the Perimeter Road on the west and east generally follows the lateral limits of the ancient Portsmouth River Valley. The valley is bounded on the west by a series of low hills extending up to elevation 840 ft MSL that have been maturely dissected; these hills expose nearly flat-lying Mississippian Age shales of the Sunbury and Cuyahoga Formations. The Sunbury and Cuyahoga Formations are also exposed in the maturely

dissected low hills east of the plant site. These consolidated Mississippian Formations dip downward to the east about 27 ft/mile (i.e., less than 1/2 a degree).

Drainage that developed at the site prior to glaciation consisted of a northward and westward flowing master stream (the ancient Teays River) and tributaries such as the ancient Portsmouth River. The Portsmouth River deposited a thin discontinuous veneer of alluvium in the site valley that has subsequently been covered by lacustrine deposits of glacial origin. Only the small streams that flow through the site contain recent alluvium.

Unconsolidated deposits at the site consist of Quaternary stream alluvium (Holocene and Pleistocene), Pleistocene lacustrine deposits of glacial origin, and older alluvium of the ancient Portsmouth River. Consolidated deposits within 500 ft of the ground surface consist of Devonian, Mississippian, and Pennsylvania shale and sandstone. Those formations in and near the site that are present within about 500 ft of the ground surface are described in the following subsections.

#### **Unconsolidated material**

1. **Fill**—Fill was placed during the 1950's to develop the site. Most of the fill ranges from 1 ft to 3 ft in thickness, but up to 20 ft of fill was placed in former stream valleys or draws to develop a plateau for building construction. The fill is composed mostly of clean, silty clay (USCS = CL); some organic material (USCS = OL) is evident at the boundary between the original ground and the fill in the area southwest of the plant. The fill is quite variable in density and strength in this area. Verification data regarding fill density and its moisture content indicate that the fill under the plant buildings was compacted to at least 95 percent of its maximum dry density according to ASTM D 698 (standard Proctor).
2. **Lacustrine deposits**—Lacustrine deposits averaging 23 ft in thickness are exposed at the ground surface over much of the site and underlie fill at the remainder of the site; these deposits have been termed the Minford clays, Minford silts, or the Minford Clay Member of the Teays Formation. The general soil profile is composed of about 16 ft of clay underlain by about 7 ft of silt. Both these soil types are firm to very stiff, overconsolidated, and classified as silty clay and silt (USCS = CL and ML, respectively), but some highly plastic clay (USCS = CH) occurs near the ground surface. The clays are mainly illite with some chlorite, minor vermiculite, and montmorillonite; the silts are mainly quartz and feldspar with illite and kaolinite.
3. **Older alluvium**—The lacustrine deposits are underlain by a discontinuous interval of clayey sand and gravel (Gallia sand) (USCS = SC and GM) deposited by the ancient Portsmouth River. The alluvium is commonly referred to as the Gallia Sand Member of the Teays Formation in the nearby Teays Valley. The average thickness is about 3 ft; the maximum thickness of the alluvium is 12 ft. It is firm to dense. The sand is mostly quartz with chert and goethite; the clay fraction is composed of illite, kaolinite, and montmorillonite.

#### **Consolidated material**

1. **Cuyahoga Formation**—This Mississippian formation crops out in hills adjacent to the site, with the base of the formation at elevation 639 ft MSL (coordinates N 8400, E 10597). Because of the 27 ft/mile regional dip, its base (as well as the other formational contacts) is at a lower elevation toward the east. When unweathered, the Cuyahoga consists of about 339 ft of hard grey to grey-green shale

- with lenses of sandstone. In the hillsides above the plant, the upper portion is reported to be conglomeratic.
2. **Sunbury Formation**—Underlying the Cuyahoga is a 19- to 20-ft thick interval of hard, black, carbonaceous shale containing pyrite and marcasite nodules. The top of this formation is at 640 ft MSL and the base is at 620 ft MSL in Boring 848DC; it underlies the unconsolidated sediments beneath most of the plant site.
  3. **Berea Formation**—At Boring 848 DC, the Berea Formation underlies the Sunbury shale and extends downward to elevation 590 ft MSL. It is composed of about 30 to 35 ft of grey thick-bedded, fine-grained sandstone with shale laminations.
  4. **Bedford Formation**—The Bedford is composed of about 98 ft of varicolored shale with interbeds of sandstone and siltstone. The sandstone may be calcareous, and some sandstone beds within it contain crude oil. The base of the Bedford in Boring 848DC is at 492 ft MSL.
  5. **Ohio Formation**—The Ohio Shale is the uppermost Devonian Formation (> 360 Ma) under the plant site. It is composed of 300 to 600 ft of dark brown, dark grey, and black fissile shale. This formation extends downward to at least 192 ft MSL.

#### 2.6.2.4 Site Structural Setting

Essentially all of the site bedrock is covered by lacustrine deposits; some stream beds contain recent alluvium. Little bedrock is exposed at the site except in the hills surrounding the plant. Neither the U. S. Army Corps of Engineers studies nor the Law Engineering Study in 1978 discovered evidence of bedrock faulting. The available data indicates that the underlying bedrock is not faulted; it has a strike of N28°E and a homoclinal dip to the southeast of about 1/2 a degree. Mapping of joints in bedrock exposures in the adjacent hills and photo lineament analysis (Geraghty and Miller 189b) show two approximately orthogonal joint sets at N55°E to 65°E and at N25°W to 40°W, respectively. The relative cluster of joint measurements around these two orientations suggests that the rock is not structurally deformed. Figure 2.6-5 shows a site plan, the locations of borings, and the limits of geologic profiles.

#### 2.6.2.5 Engineering Geology

The available evidence indicates the favorable performance of the facility since its construction in the 1950's with respect to bearing capacity, settlement, and modest seismic events.

No shears, folds, or other structural weaknesses are known to be in the bedrock. Measurements of joint sets in bedrock exposed around the plant site exhibit jointing typical of undeformed bedrock. These joints have no effect on the performance of foundations since they are covered by an interval of lacustrine glacial deposits. No evidence from the borings indicates zones of deep weathering that might indicate faulting or shearing.

No published data exist on unrelieved stresses in the bedrock, but the geologic history suggests that the bedrock may still be undergoing a very slow isostatic rebound. This rebound is due to a combination of the past loading and subsequent unloading of the bedrock by the Pleistocene glaciers and/or stress relief from erosion of the unconsolidated lacustrine sediments.

The consolidated bedrock within 500 ft of the ground surface is predominately clastic in origin (shale and sandstone). Although the Berea sandstone underlying the site is not calcareous, portions of the Berea Formation are calcareous in other areas. A calcareous sandstone might be subject to a slight loss in volume due to solution. The likelihood of such volume loss at the site is very low.

Weathering of portions of the Sunbury shale containing marcasite and pyrite may produce some net expansion, but these formations are not exposed at the ground surface at the site and such weathering should have no effect on the facility.

Most of the unconsolidated soils are cohesive and overconsolidated (i.e., they are not thixotropic) and relatively uniform in thickness and extent. The soils exhibit a low potential for liquefaction and differential settlement. Cohesive soils exposed at the surface may exhibit minor shrinkage cracks resulting from moisture loss.

The geologic literature and records of mineral production in the site area indicate no mineral extraction has been done beneath the site. The potential exists for minor oil and gas accumulations in the underlying consolidated strata, but there are no records of significant gas or oil production within 5 miles of the site.

The soil at the site is primarily low plasticity clay and silty clay (USCS = CL and ML). The bedrock is composed of hard shale and sandstone.

No limestone, dolomite gypsum, salt, or marble strata are contained within the uppermost 500 ft of the bedrock underlying the plant. Although thin-bedded strata of the Berea sandstone are reported to be calcareous in southern Ohio, none of the literature indicates it is calcareous at the plant site. Bedrock solution, caves, and karst development are not a consideration at the site.

The regional geologic history and extensive amount of exploratory data indicate no evidence of tectonic depressions, shears, faults, or folds.

The plant uses process water from the aquifer below the Scioto River, and no groundwater is withdrawn from the subsurface at the plant site. There is no shallow or deep well injection of water or other liquids or waste at the plant site, and there has been none in the past.

The exploratory and laboratory test data indicate that the glacial and alluvial soils are overconsolidated and have moisture contents well below their liquid limit (i.e., they are not thixotropic). Engineering studies have shown the soils are only moderately compressible under applied foundation loads, and the satisfactory performance of the various foundations attests to that. The potential is low for surface fissuring of soils resulting from a period of extreme drought (desiccation).

The 1952 Site Clearing and Grading plan shows that building areas that required fill received Class C fill. Class C fill consisted of soil with crushed limestone that was compacted to at least 95 percent of ASTM D 698. Other documents indicate that the compaction requirement for engineered fill was at least 95 percent of the soil's maximum dry density according to ASTM D 698. The criterion for compaction of fill placed outside buildings is not known, but one document indicates that the fill where Building X-344 was constructed was densified to an average of 94 percent of ASTM D 698.

Foundations for the major structures (Buildings X-330, X-333, X-326, X-700, X-710, and X-720) bear upon the soil at shallow depths (<5 ft) using conventional foundations proportioned for allowable bearing capacities up to 4.0 kips/ft<sup>2</sup>. A tunnel in Building X-705 bears on soil at a depth of about 25 ft (i.e., elevation 648 ft amsl). Construction records document that where fat clays (i.e., highly plastic clays wherein physical properties are very sensitive to changes in moisture content) or soft alluvial soil were encountered at foundation locations, they were excavated and replaced with stone or low plasticity clay compacted to 95% of its maximum dry density according to ASTM D 698.

The studies by the U. S. Army Corps of Engineers and Law Engineering in the 1970's in the area south-southeast and southwest of the plant found groundwater between 650 ft MSL and 665 ft MSL. The basal older alluvium exhibits no evidence of artesian conditions. Limited data on groundwater fluctuations indicate variations of between 3 ft to 5 ft over a period of 6 months. The groundwater level responds to annual precipitation.

Except in rare instances, no significant problems were encountered with groundwater during construction of the facility. Most foundations bear upon the stiff lacustrine soils at depths of 5 ft or less below the finished floor elevation of the buildings. In instances where deep excavations were required to install features such as tunnels (i.e., the tunnel in Building X-705), unstable soil was encountered below the groundwater level.

No slopes within the Perimeter Road have inclination of 3H:1V or greater except for one slope; this slope is not adjacent to any structures (ERCE 1990). Low inclination slopes less than 20 ft in height that have soil parameters of  $\phi = 10^\circ$ ,  $c = 1000$  will have a static safety factor of at least 2.0 and a dynamic safety factor of at least 1.5 under a peak ground acceleration of 0.21 g. The natural ground and engineered fill upon which the structures are founded have been analyzed for shear failure and settlement. Design documents show the factor of safety against shear failure under static conditions is more than 2.0, and predicted total settlements of foundations are less than 2 in. Because of the stiff nature of the foundation soils, negligible settlement will occur as a result of the evaluation basis earthquake (EBE).

#### 2.6.2.6 Geologic Hazards

This subsection summarizes potential regional and sitewide geologic hazards at PORTS. The following sections provide supporting details. Conclusions are based on a report by ERCE (1990) and on-site drilling data provided by COE and by LETC (1978).

##### 2.6.2.6.1 Subsidence Hazard

There is very little potential for natural or man-induced subsidence at PORTS. No carbonate or evaporite rocks are found within 500 ft of the surface. Significant solution cavities are unlikely to form at greater depths, without which karst topography cannot develop at the surface. The youngest strata beneath the site are Mississippian age; the oldest coal seams are in still younger nearby Pennsylvanian age rocks but are not present beneath the site. No other mines of any type are within 5 miles of the site. There are five natural gas wells within 5 miles of PORTS; the nearest well is located about 3000 ft northeast of the site. These wells produce small quantities of gas from the Ohio shale, which lies about 500 ft beneath the site. Subsidence related to this production is likely to be small and relatively uniform at the surface. No other hydrocarbons are produced within 5 miles of the site, and any future hydrocarbon or groundwater production from fully consolidated Paleozoic rocks beneath the site would be unlikely to cause significant subsidence. There is little or no potential for groundwater production from the lacustrine (lakebed) silts and clays beneath

the site. The Pleistocene alluvial aquifer beneath the on-site lakebed sediments is too limited in extent to support significant groundwater production. Off-site groundwater production is currently limited; there is no on-site production of groundwater. Differential settlement of construction fill and lakebed sediments ran its course within the first few years of construction at PORTS.

#### 2.6.2.6.2 Landslide Hazard

There is very little potential for landslides at PORTS. Slopes are generally gentler than 3H:1V. Static and dynamic factors of safety for low inclination slopes of less than 20 ft in height generally exceed 2 and 1.5, respectively, for cohesive clays with friction angles less than 10° and cohesive strengths exceeding 1000 psi. The dynamic factor of safety is based on an earthquake ground motion of 0.21 g. Slopes are unlikely to fail unless erosion during a flood oversteepens the slope's toe.

### 2.6.3 Analysis of Geologic Stability

#### 2.6.3.1 Earthquake History

Between 1776 and August 17, 1990, 264 earthquakes have occurred within 200 miles of the site.

The location of the epicenters of the largest recorded earthquakes within 200 miles of the plant are shown in Figure 2.6-6. The record extends from 1776 through August 17, 1990, and includes all tremors shown on the figure with Richter magnitudes of 4.0 or greater, as well as all earthquakes where a magnitude has not been assigned. Events with a magnitude of up to 3.9 are not shown. The tremors shown on the figure with no assigned magnitude are of low energy. Two earthquakes of Richter magnitude 5.0 or greater (5.80 FA, 1897; 5.1 mb, 1980) have occurred within this 200-mile radius in the 204-year period. The 1980 event had an epicenter in the central stable portion (Interior Low Plateaus physiographic province) and the 1897 event occurred in the deformed Appalachian Highlands (Valley and Ridge physiographic province). The Richter 5.1 mb event in northern Kentucky at 38.2°N, 83.9°W occurred at depth in the basement where geologic structure is poorly understood. The focal mechanism for the Kentucky earthquake is consistent with the contemporary stress field (Mauk et al, 1982). The 5.80 FA May 31, 1897, event at 37.3°N, 80.7°W on the Virginia-West Virginia border is believed to have been located in the basement, based on observations of recent seismic activity by Bollinger and Wheeler (1988). A basement structure has been tentatively identified by Bollinger and Wheeler that has a more northerly orientation than surficial Appalachian highland structures. Observations of Mauk, Bollinger, and their coworkers raise doubts that surficial structures bear any relation to contemporary seismicity in this region. PORTS operating personnel indicate that the facility has performed without seismic damage or interruption of operations during its existence, and there have been no observed ground ruptures, sand boils, or subsidence at the site.

#### 2.6.3.2 Identification and Description of Capable Faults

Including multiple fault systems and groups of related faults, 376 faults are mapped within a 200 mile radius of the site. These have been compiled from existing published and unpublished geologic literature. Fault studies by the Tennessee Valley Authority (TVA), which contained information on 375 of these faults, show that only the "White Mountain Fault Zone" may be capable, i.e. exhibited movement at or near the surface in the past 35,000 years or movement of a recurring nature in the past 500,000 years. This fault is 20.5 miles in length and is located in Bell and Knox Counties, Kentucky, about 155 miles south-southwest of the site.

More recent studies suggest the possibility that some faults have been active more recently than earlier believed. Such faults are located in Illinois, Indiana, and Kentucky.

A few low-displacement thrust faults to the west in Indiana have been described by Ault et al. (1985) and Ault and Sullivan (1982), and similar faults in southern Illinois have also been described (ERCE 1990). In each case, faults are described as (1) being post-Pennsylvanian and pre-Pleistocene in age, (2) thrust faults that are contained entirely within Pennsylvanian coal seams, and (3) aligned with the contemporary stress field.

The Kentucky River and Rock Castle fault systems form the northern and southern boundaries, respectively, of the Rome trough in eastern Kentucky (Harris and Drahovzal 1996). The Rome trough extends eastward from central Kentucky. Then it bends northeasterly through western West Virginia and western Pennsylvania to western New York. The Rome trough is a late Precambrian to lower Paleozoic graben (rift zone) that contains 10,000 ft or more of Cambrian sediments. The Paint Creek fault system lies within the Rome trough. The Lexington fault system and the Precambrian Grenville Front form the western boundary of the Rome trough.

At least one fault system (Kentucky River) within the Rome trough has reactivated in the contemporary stress field. Vanarsdale (1986) mapped subtle Pliocene/Pleistocene displacements in alluvium along the Kentucky River fault system and possible Holocene warping along branches of this system. Senses of displacement (i.e., strike-slip and reverse faulting) along these structures are compatible with the contemporary stress field of Zoback (1992). However, there is no evidence that the Kentucky River fault system is capable in the regulatory sense.

The Rough Creek fault system (almost 200 miles to the southwest in Kentucky) is shown on numerous geologic quadrangles across Kentucky as being post-Pennsylvanian, pre-Pleistocene (loess) in age.

Thrust faulting, generally associated with strata in the Valley and Ridge province, is found within the southeastern portion of the 200-mile radius of the site. The nearest example of this is the Pine Mountain fault. Further to the southeast in Virginia and Tennessee, numerous faults and portions of faults are shown as being of post-Pennsylvanian age. The general consensus of opinion is that the hundreds of thrust faults within the Valley and Ridge (including the Pine Mountain fault) and within the Blue Ridge occurred as a result of the Appalachian orogeny. These low-angle, non-basement-penetrating thrust faults are not believed to be active in the contemporary stress field.

Most historical seismicity in the region is believed to be associated with reactivation of deep-seated Paleozoic and Precambrian rift zones in the contemporary stress field. Many of these rift zones have not been well documented and have no surface expression. One exception is the Rome trough, a Precambrian/lower Paleozoic rift zone that is oriented in an east-west direction through east central Kentucky and West Virginia. The Rome trough is bounded on the north and south by the Kentucky River and Castle Rock fault systems, respectively. Another fault system (Irvine-Paint Creek) lies within the Rome trough. All of these fault systems are easily traced on the surface. Deep wells drilled between the Kentucky River and Castle Rock fault systems encounter abnormally thick sections of Cambrian sediments. Vanarsdale (1986) shows that the Kentucky River fault system was reactivated as recently as Pliocene-Pleistocene time. Total displacement over the last several million years is on the order of 1 or 2 ft.

Branches of the Kentucky River fault system are not believed to be capable of surface rupture in the regulatory sense because only one displacement of limited magnitude (1 to 2 ft) has been identified on any

one fault in the last 1.6 million years. One of the strongest twentieth century earthquakes in the eastern United States occurred in this general region: the Maysville, Kentucky, earthquake of July 1980 (Mauk et al. 1982). The relationship between this earthquake and the Rome trough is uncertain.

#### **2.6.3.3 Surface Faulting**

The published map of Ohio [1920, revised 1947 and subsequently reprinted 1981 (Bownocker 1981)] shows no faults within 50 miles of the site. The state map of Kentucky shows faults about 50 miles southwest of the site and 60 miles south of the site.

The geologic setting of the site suggests there is a low probability of faulting within 5 miles of the site. No data from the three extensive geotechnical studies at the site (rock shearing, sharp changes in strata dip, and flexures) are characteristic of faulted rocks. The available data indicates the site bedrock is not faulted.

Although 7½-minute geologic maps are not available, Ohio Geological Survey representatives do not believe there are any capable faults in the area nor within 5 miles of the PORTS facility. The available seismic and geologic data and geologic history suggest that capable faults are not likely in the area.

The USGS National Earthquake Information Center Earthquake Database System shows no record of earthquakes within 5 miles of the site from 1776 through August 17, 1990. The nearest reported earthquake hypocenter was about 22 miles north of the site (39.3°N, 83.0°W) on November 22, 1899; its epicenter is unknown. That earthquake had a reported Modified Mercalli Intensity of IV.

The focal depths of the 264 earthquakes of record within 200 miles of the site have ranged from 0.62 to 20 miles. Nearly all earthquakes with accurate focal depth determinations occurred within the geologic basement at depths of 6.2 miles or more.

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Figure 2.6-1 Regional physiographic map (after Fenneman and Johnson 1946)

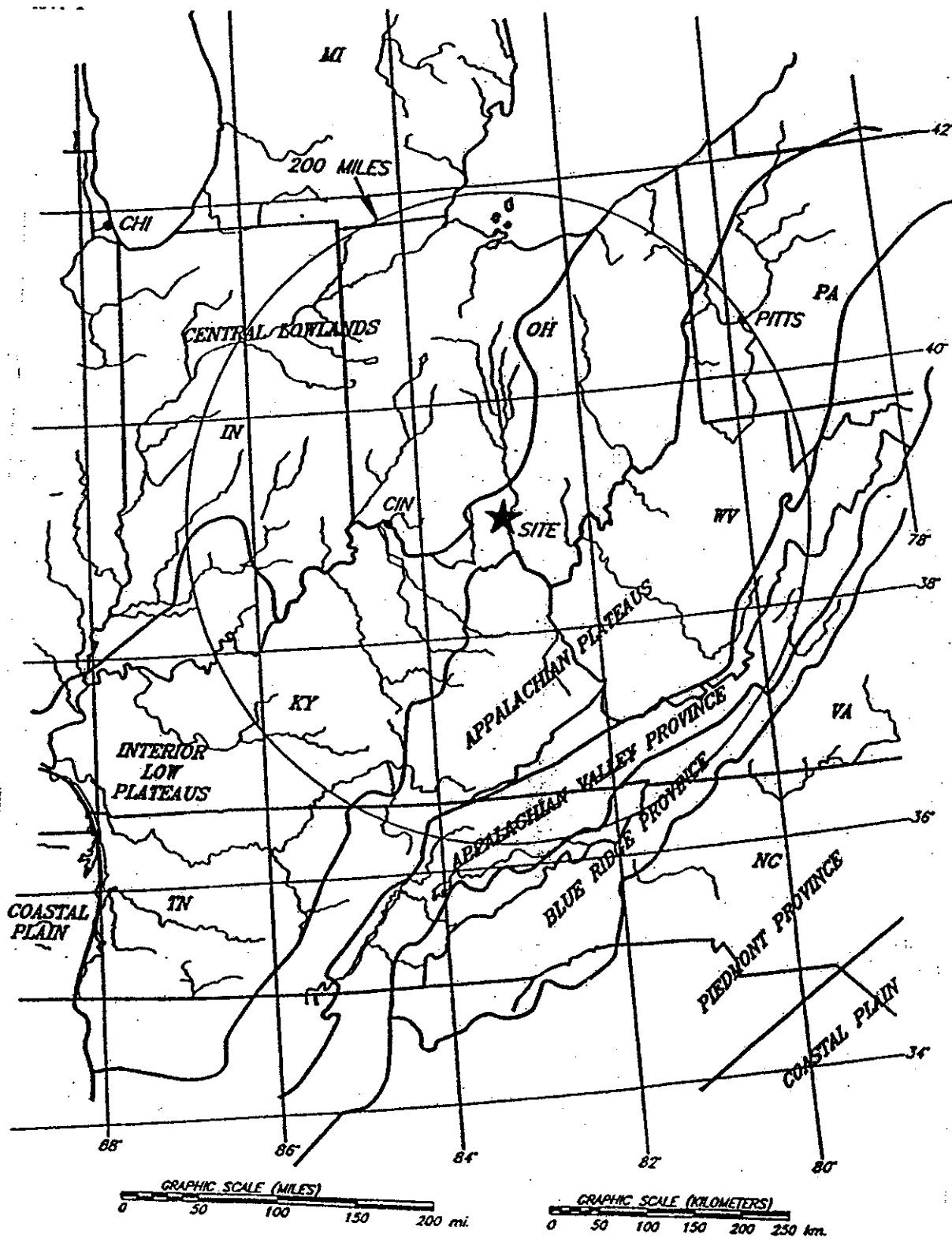


Figure 2.6-2. Regional geologic setting (modified from Rudman et al.).

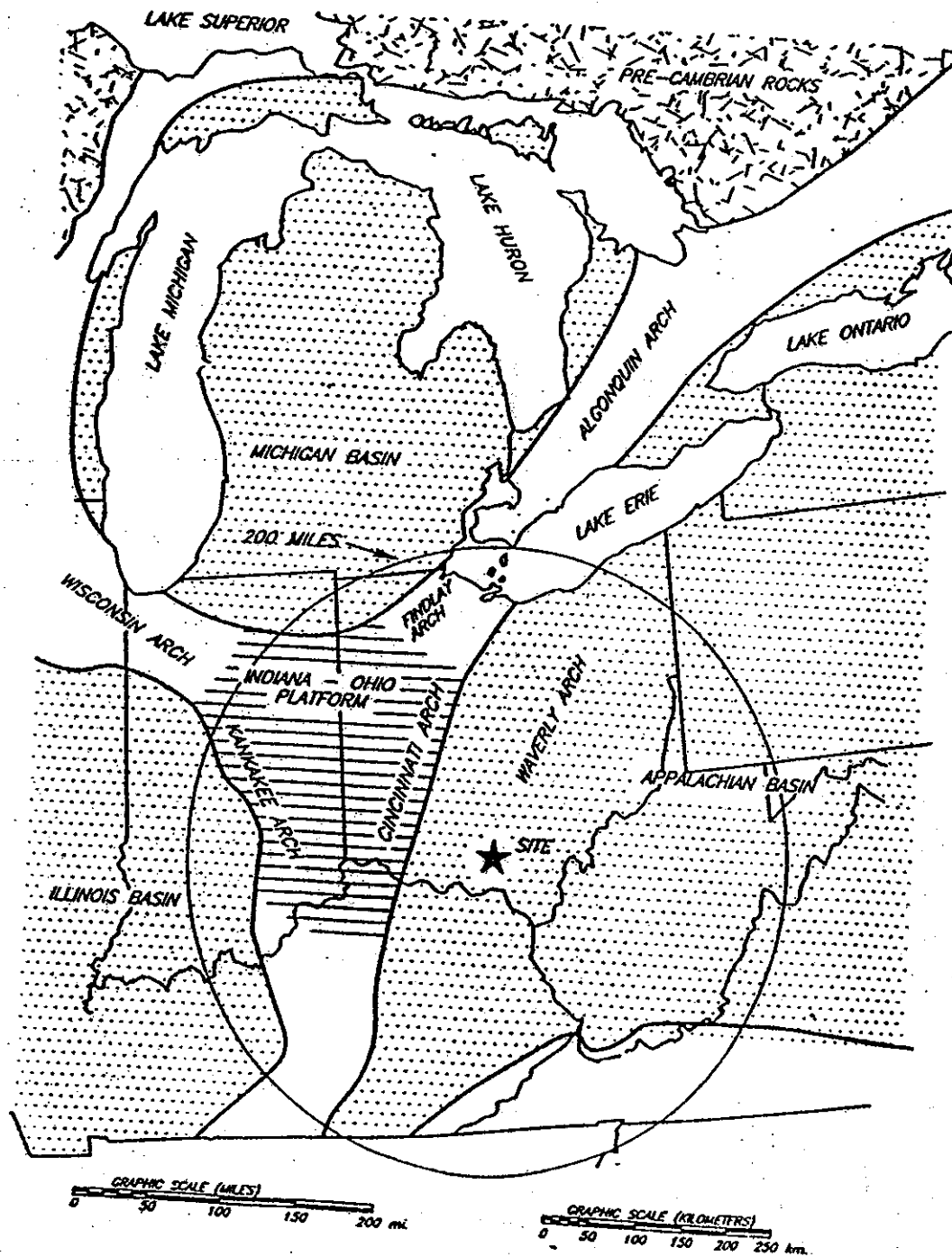
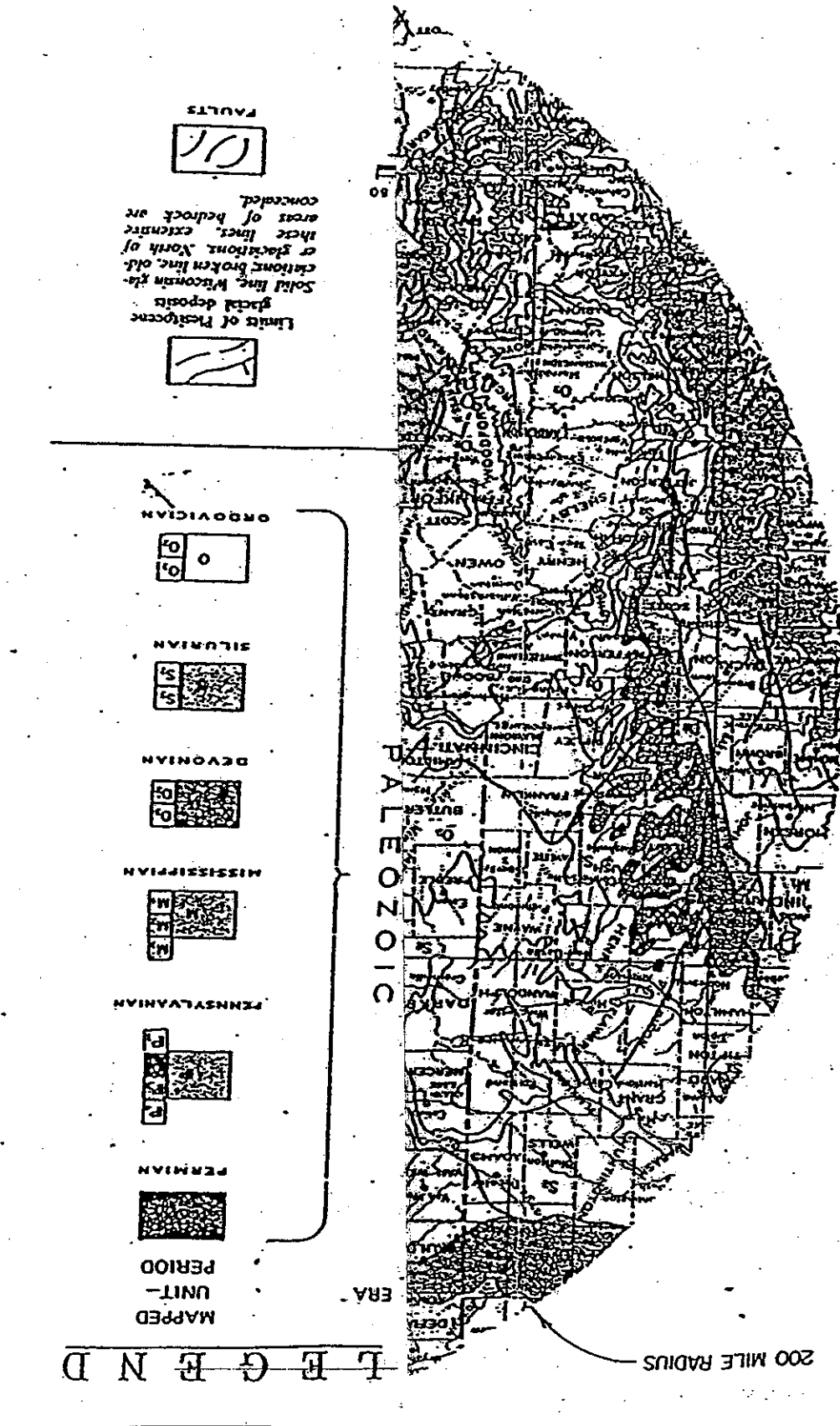


Figure 2.6-3 Regional Geologic Map. (From King, 1974, the U.S.G.S. Geologic Map of the United States, 1974)



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Figure 2.6-4. Regional profile (From King 1974).

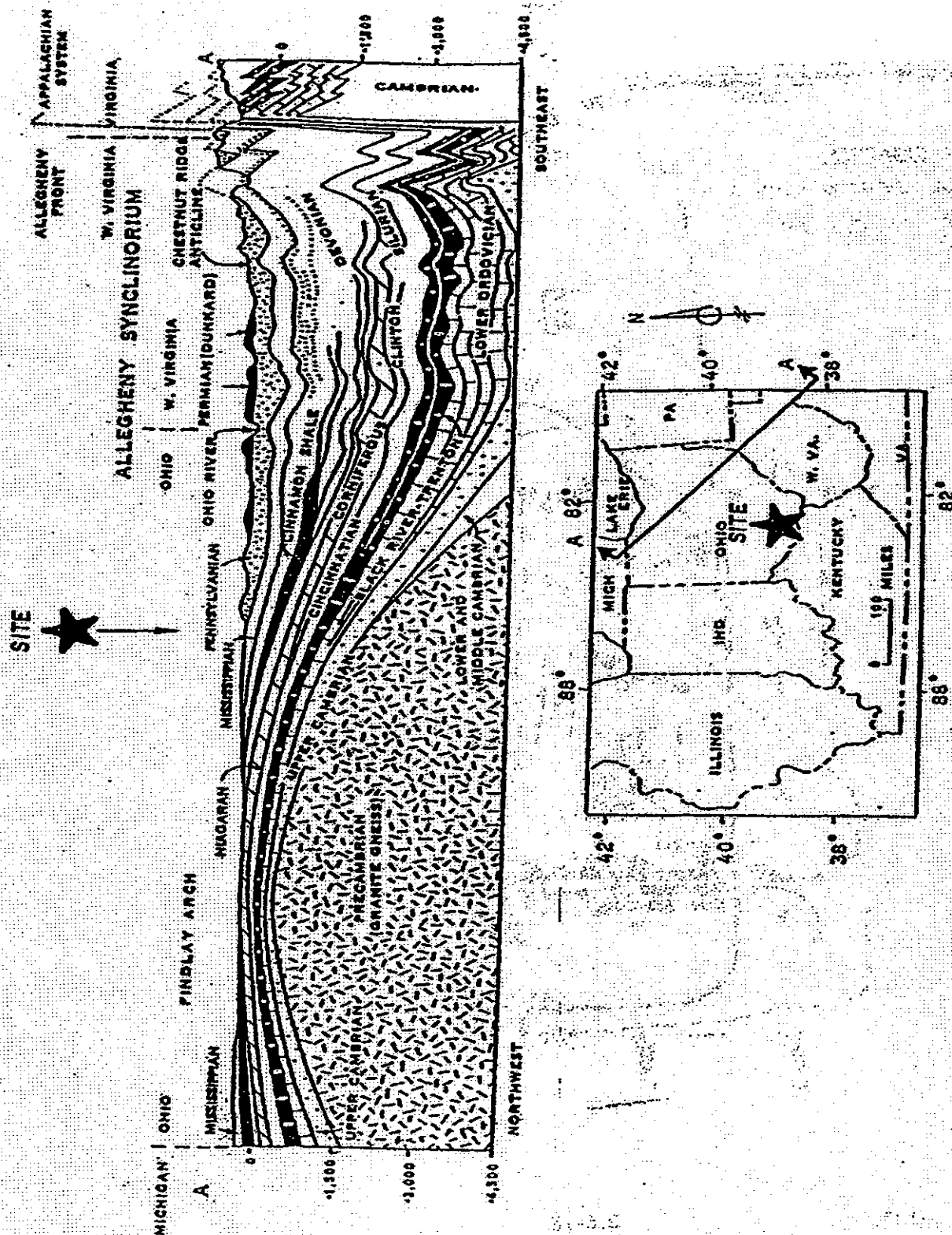


Figure 2.6-5. Site plan, locations of summary borings, and geologic profile limits. (1 in. = 2,000 ft.)

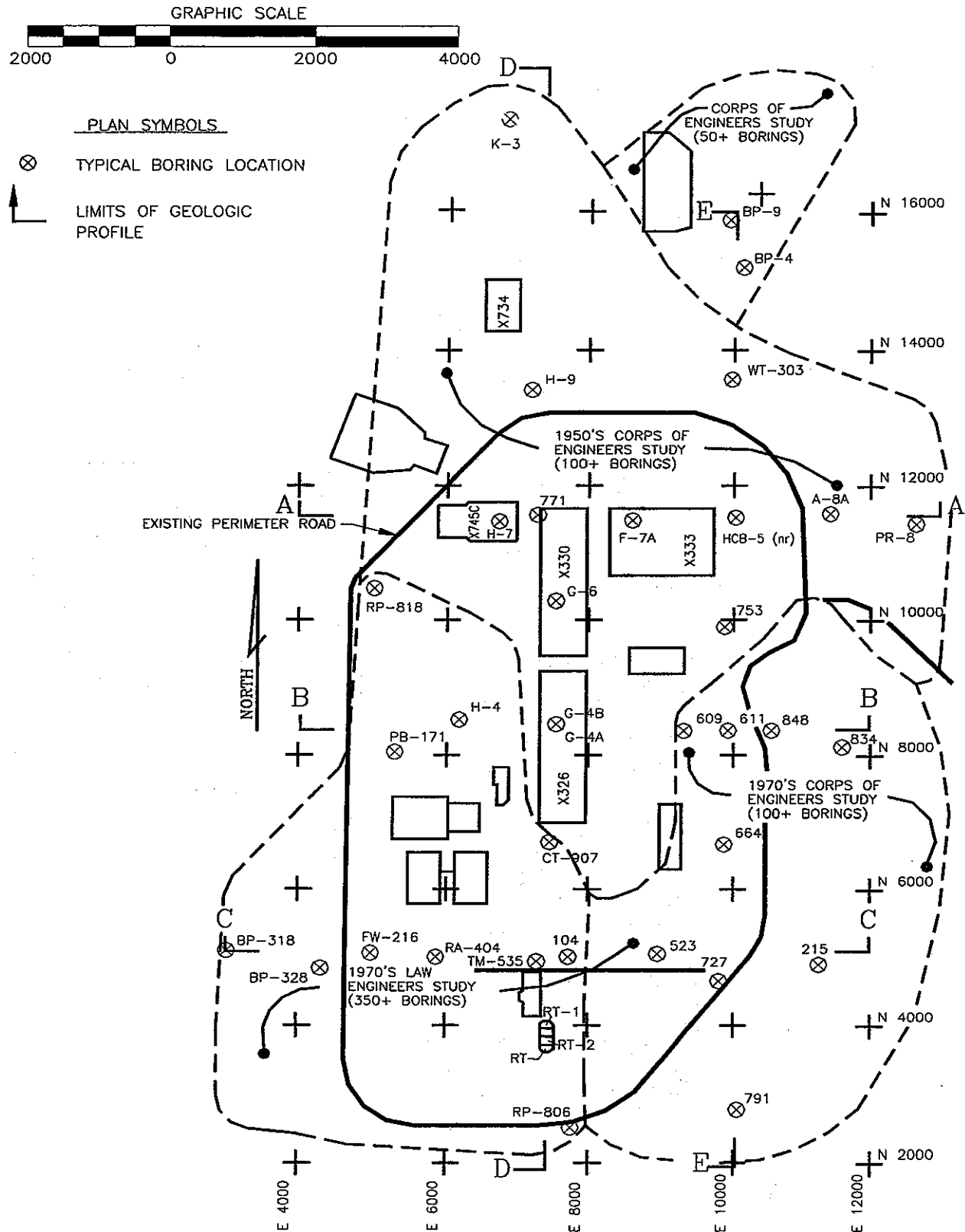
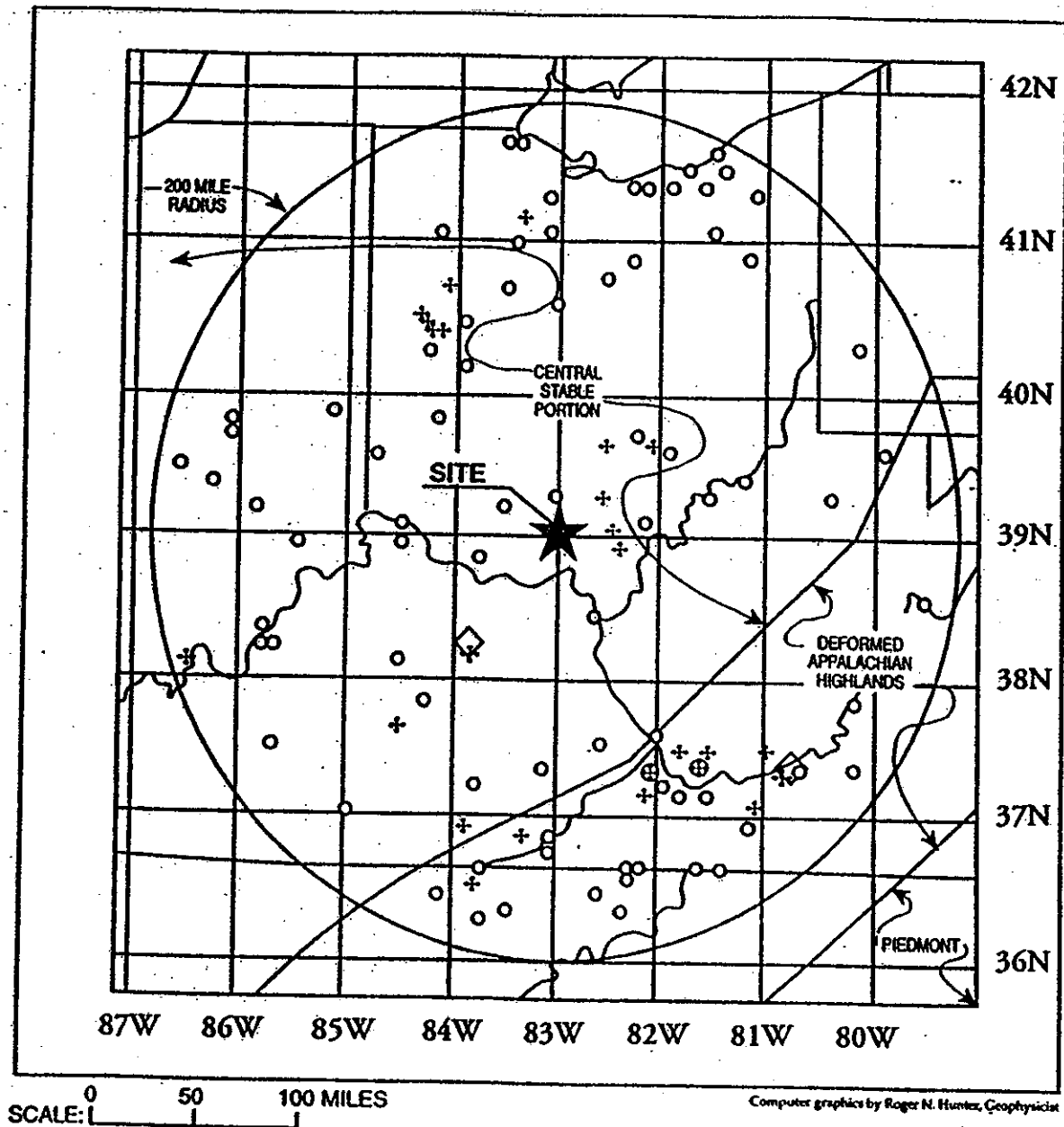


Figure 2.6-6. Seismotectonic provinces and epicenters of historical earthquakes, 1776-1990.



RICHTER MAGNITUDES (ONLY UNKNOWN AND 4 OR GREATER MAGNITUDES ARE SHOWN)

○ UNKNOWN MAGNITUDE      4 +      5 ◇

U. S. Geological Survey, National Earthquake Information Center  
Data taken from the Earthquake Data Base System

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## 2.7 NATURAL PHENOMENA THREATS

The natural phenomena (NP) hazards described in this section are earthquake, wind, and flood. The NP hazards were evaluated to determine the evaluation basis levels in accordance with DOE requirement documents. The NP hazard evaluations and evaluation basis levels are described in the following sections.

### 2.7.1 Earthquake Hazard

The earthquake hazard was evaluated by performing site-specific studies. The site-specific studies included performing probabilistic and deterministic seismic hazard analyses to define rock outcrop motions and soil amplification analyses to determine the EBE ground surface motions.

The seismic hazard analyses are described and documented in *Seismic Hazard Evaluation for the Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio* (Risk Engineering, Inc. 1992). The probabilistic seismic hazard analyses were performed using the Lawrence Livermore National Laboratory (LLNL) and Electric Power Research Institute (EPRI) seismic hazard methodologies. The LLNL and EPRI seismic hazard methodologies represent major efforts to characterize the seismic hazard for nuclear power plants in the central and eastern United States and use the most recent, up-to-date understandings of seismicity and ground motion relations for the region. The results of these studies and the two methodologies were used to develop the seismic hazard for PORTS. Both the LLNL and EPRI studies utilize a point-source representation of earthquakes, thereby ignoring the nonzero dimensions of earthquake ruptures. This simplification is appropriate for this site because earthquakes with large ruptures are highly unlikely to occur near the site (because of low values of maximum magnitude).

The probabilistic seismic hazard results from the LLNL and the EPRI methodologies were used in accordance with the *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites* (DOE 1992) to develop site-specific uniform hazard rock response spectra. The DOE guidelines (DOE 1992) provide a methodology for combining the seismic hazard results from LLNL and EPRI to obtain a mean uniform hazard response spectra. Additional evaluations were made to address the uncertainty in the low frequency range (2.5 Hz and less) of the response spectra and are documented in a letter report from the Center for Natural Phenomena Engineering (Hunt 1993) and in *Seismic Hazard for the Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio, Department of Energy Reservations* (CPNE 1995).

The deterministic seismic hazard analyses was performed by obtaining actual earthquake records with magnitudes and site characteristics similar to the Portsmouth seismic environment. The response spectra obtained from the earthquake recordings were compared with the probabilistic site-specific uniform hazard response spectra to illustrate that the uniform hazard response spectra were appropriate for the PORTS site.

Independent calculations and a review of the seismic hazard analyses for the site were performed by USGS. The results of the USGS review are documented in *Review of Earthquake Hazard Assessments of Plant Sites at Paducah, Kentucky, and Portsmouth, Ohio* (USGS 1992a). The independent review of the seismic hazard results by USGS indicated that the seismic sources, recurrence rates, maximum magnitudes, and attenuation functions used in these analyses were representative of a wide range of professional opinion and were suitable for obtaining probabilistically based seismic hazard estimates. The USGS independent calculations for peak horizontal rock acceleration at the annual hazard probability of  $1 \times 10^{-3}$  resulted in about 0.08 G, which compares favorably with the 0.06 G derived from combining the EPRI and LLNL results according to the DOE guidelines (DOE 1992). The USGS uniform hazard response spectra are also in

reasonable agreement with the site-specific spectra, particularly in the frequency range 2.5 Hz and less, which is the range of the predominant frequencies of the structures at this site. The differences in the uniform hazard response spectra can be attributed mainly to the magnitudes of the earthquakes used in the attenuation functions, resulting in the USGS results being more representative of stiff soil accelerations than rock accelerations.

Based on the rock outcrop motions defined in the seismic hazard analyses, soil amplification and liquefaction evaluations were performed. The soil amplification evaluation is documented in a COE report, *Site-Specific Earthquake Response Analysis for Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio* (Sykora and Davis 1993). The soil amplification analyses were performed to calculate a reasonable range of expected site-specific, free-field earthquake responses to the rock outcrop motions of three hazard level earthquakes: 500-, 1000-, and a 5000-yr events. From the geotechnical and geophysical investigations, 15 individual soil columns were derived for use in the amplification analyses. Also an average soil column was created to conduct sensitivity studies. The average soil column is used to represent the overall site. The geotechnical information from past site studies defining the variation of shear modulus and damping ratio with shear strain was used along with standard relationships developed by others. These standard relationships typically represent a best-estimate fit of numerous compiled data from investigations conducted throughout the United States.

The computer program SHAKE (Sykora and Davis 1993) was used to perform the soil amplification analyses and to calculate the free-field ground motions for each of the 15 soil columns and the average soil column. The predominate site period is about 0.1 sec. Other site periods were also calculated corresponding to sites with a thicker soil deposit or higher shear wave velocity. The motions calculated at the ground surface of free-field (soil over rock) were amplified over rock outcrop motions for all cases at almost all periods. Sensitivity studies were also conducted using the average soil column. The effects of bedrock impedance ratio, depth to bedrock, shear modulus relationship used, damping ratio relationship used, and the maximum shear modulus were investigated. The results of the sensitivity studies suggest that the depth to bedrock and maximum shear modulus are the two most important factors for the site response calculations. The bedrock impedance ratio is also important but to a lesser degree. The assignment of shear modulus and damping ratio relationships was found to have a small effect on the analyses, primarily because the site-specific relationships do not vary considerably and are very similar to the standardized curves. It was determined that the range of response using the 15 individual soil columns is comparable to, or even wider than, the results of the sensitivity studies considering all possible combinations of variability and uncertainty using guidelines such as those established by NRC (NRC 1989). Therefore, the individual responses from the 15 soil columns were used to determine the free-field ground surface motions. The soil liquefaction evaluation is documented in a report prepared by ERCE, *Portsmouth Gaseous Diffusion Plant, Final Safety Analysis Report, Section 3.6, Geology and Seismicity* (ERCE 1990). The liquefaction evaluation demonstrated that liquefaction was not a concern for the EBE at the site.

Based on the seismic hazard analyses and soil amplification evaluation, the seismic hazard curve for peak ground surface acceleration and the EBE ground response spectra were determined. The seismic hazard curve for peak horizontal ground surface acceleration is shown in Figure 2.7-1. The EBE return period to be used for the site is to be 250 yr. The justification for continued use of an approximate 250-year return period for the evaluation basis earthquake was developed by DOE (DOE 1995). The justification demonstrated that the risk of serious injuries or deaths per year from a conservative estimate of the releases from a collapse of major cascade buildings was low and low in comparison to normal societal risks. In addition, the plants are not expected to operate for a large number of additional years. Given the low risk from a major release,

previous estimates of building capacities, and short life of the facilities, the facilities were not believed modifiable within the remaining life in such a time frame that benefit would be achieved.

Based on a return period of 250 yr, the EBE horizontal ground response spectra for 5% damping is shown in Figure 2.7-2. The EBE response spectra was determined by scaling the 500-yr return period response spectra by the ratio of PGA of the 250-yr return period earthquake divided by PGA of the 500-yr return period earthquake. The vertical earthquake ground motion is two thirds of the horizontal ground motion. Earthquake time histories representative of the EBE ground response spectra were also developed for use in structural and equipment evaluations. The development of these earthquake time histories is documented in a report by Risk Engineering, Inc., *Development of Artificial Earthquake Ground Motions for the Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio*, (Risk Engineering, Inc. 1993).

### 2.7.2 Flood Hazard

The flood hazard was evaluated by performing site-specific river flooding analyses from extreme river flooding and flooding due to local intense site precipitation. These flood hazard studies are documented in *Extreme Flood Estimates Along the Scioto River Adjacent to the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio* (Wang et al. 1992) and *Local Drainage Analysis of the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio, During an Extreme Storm* (Johnson et al. 1993).

The Scioto River, which flows in a north-to-south direction and empties into the Ohio River at Portsmouth, is located 1.9 miles west of the plant site. The plant site is situated about 141 ft above the banks of the Scioto River. The river flood study evaluated the potential for inundation of the plant site during a flood having a recurrence interval of 10,000 yr on the Scioto River. This was accomplished by applying statistical methods to extrapolate flood data recorded at the Higby, Ohio, gauging station to the 10,000-yr interval. Two different statistical methods, as well as a least-squares methodology, are utilized to calculate the flood stage. The calculated flood stage is about 97 ft below nominal plant grade; therefore, river flooding does not constitute a hazard.

A local drainage analysis was also performed for the plant site. The intent of this study was to determine whether local flooding from creeks, ditches, storm sewers, culverts, and roof drainage systems during an extreme storm having an approximate recurrence interval of 10,000 yr poses a serious concern. The task was accomplished by performing hydraulic and hydrologic analyses of creeks, ditches, storm sewers, culverts, and roof drainage systems using standard methods to determine if the influx of rainwater that occurs during an extreme storm can be conveyed away from critical, safety-related structures. The results of the study indicated the local intense precipitation does not pose a flood hazard to structures except where roof ponding can occur. The effects of roof ponding were considered in the structural evaluations, which are described in Chapter 4.

### 2.7.3 Wind Hazard

The wind hazard was evaluated by performing a site-specific analysis. The site-specific study is documented in *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites* (Coats and Murray, 1985). LLNL utilized recognized experts in the field of wind hazards for the generation of this study which establishes the wind/tornado hazard curves for the Portsmouth site.

The wind hazard curve is shown in Figure 2.7-3 (Coats and Murray, 1985). The evaluation basis wind (EBW) return period to be used for the site was specified by DOE to be 250 yr (Jackson 1995). Based on a return period of 250 yr, EBW has a wind speed of 78 mph.

The justification for use of an approximate 250-year return period for wind was based on the rationale for the seismic return period. Wind damage at the plants is less likely to result in a significant release of hazardous material than the direct failure of cascade equipment under seismic loading. Wind is more likely than seismic loads to cause exterior damage to the buildings without extensive damage internally. In addition, high winds will rapidly disperse any hazardous material released as well as reduce exposure times down wind. Therefore the risk of serious injuries and/or deaths is substantially lower for high winds than an equivalent seismic event. Given the much lower risk of public health consequences with high wind damage than from a seismic event and the short life of the facilities, modifications would not achieve significant benefit.

Extreme wind dominates in the 250-year frequency range for the PORTS. As noted above, the extreme wind value is used in this study and tornado wind loadings are not considered. Tornadoes do occur in Southern Ohio; however, specific analyses of the frequency of tornadoes in the region show that they are rare. Recent analyses covering a 32-year period for the United States show an estimated strike frequency within the fenced area of the plant of approximately 1 event per 30,000 years at PORTS. Although tornadoes are extremely destructive in a localized area, the actual damage expected to cascade internal equipment and structures is also expected to be substantially less than the seismic event and may be minimal on the cell floor due to the large reservoir of air between the building roof and the cell floor of each building. Thus given the short operating life of the plants and the expectation of risk far less than a seismic event, a 250-year return period excluding tornadoes is believed justified.

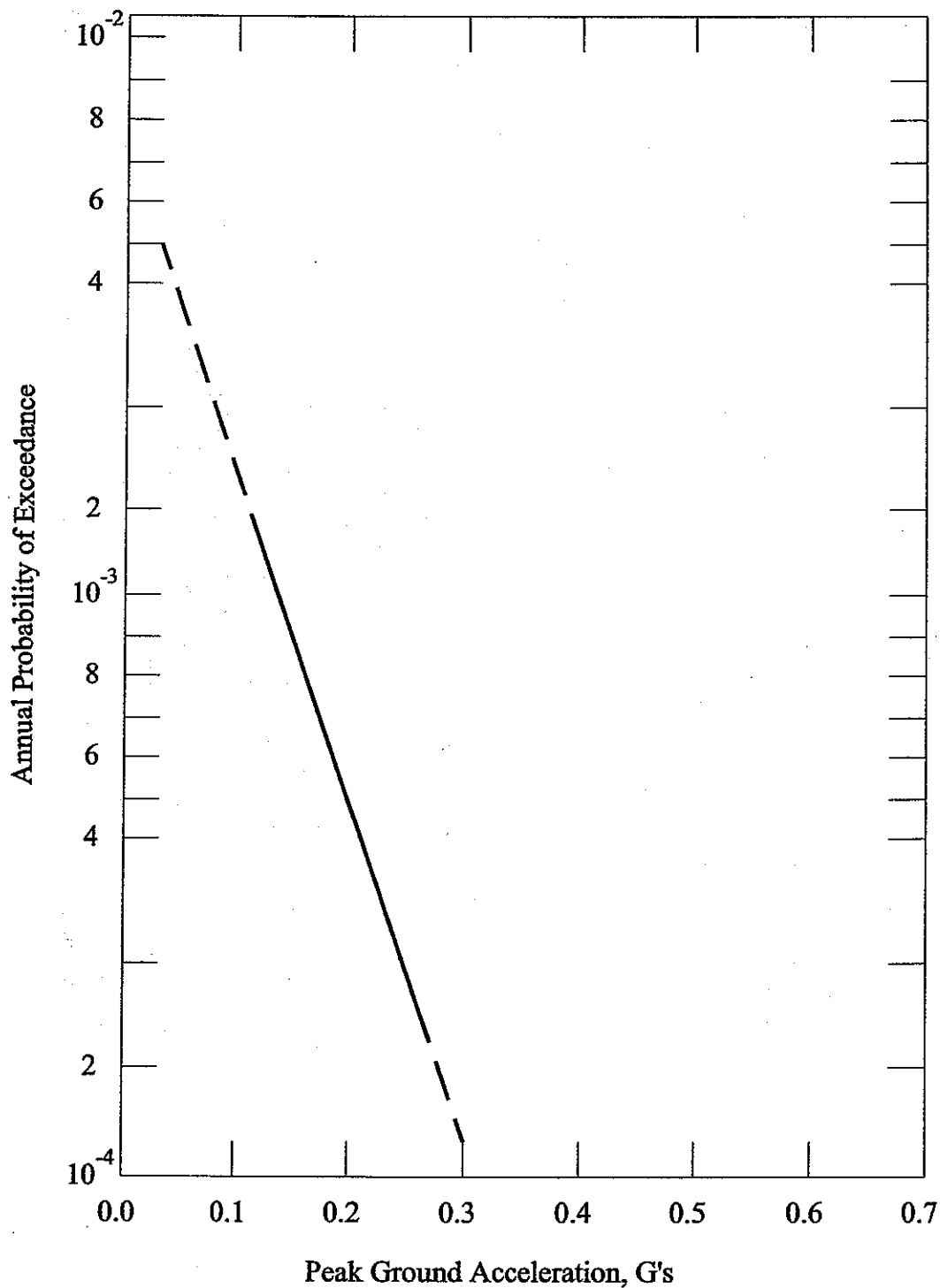


Figure 2.7-1 Mean seismic hazard curves for the Portsmouth area (ES/CPNE-95-2.  
*Seismic Hazard Criteria for the Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio.*  
U.S. Department of Energy Reservations. December 1995)

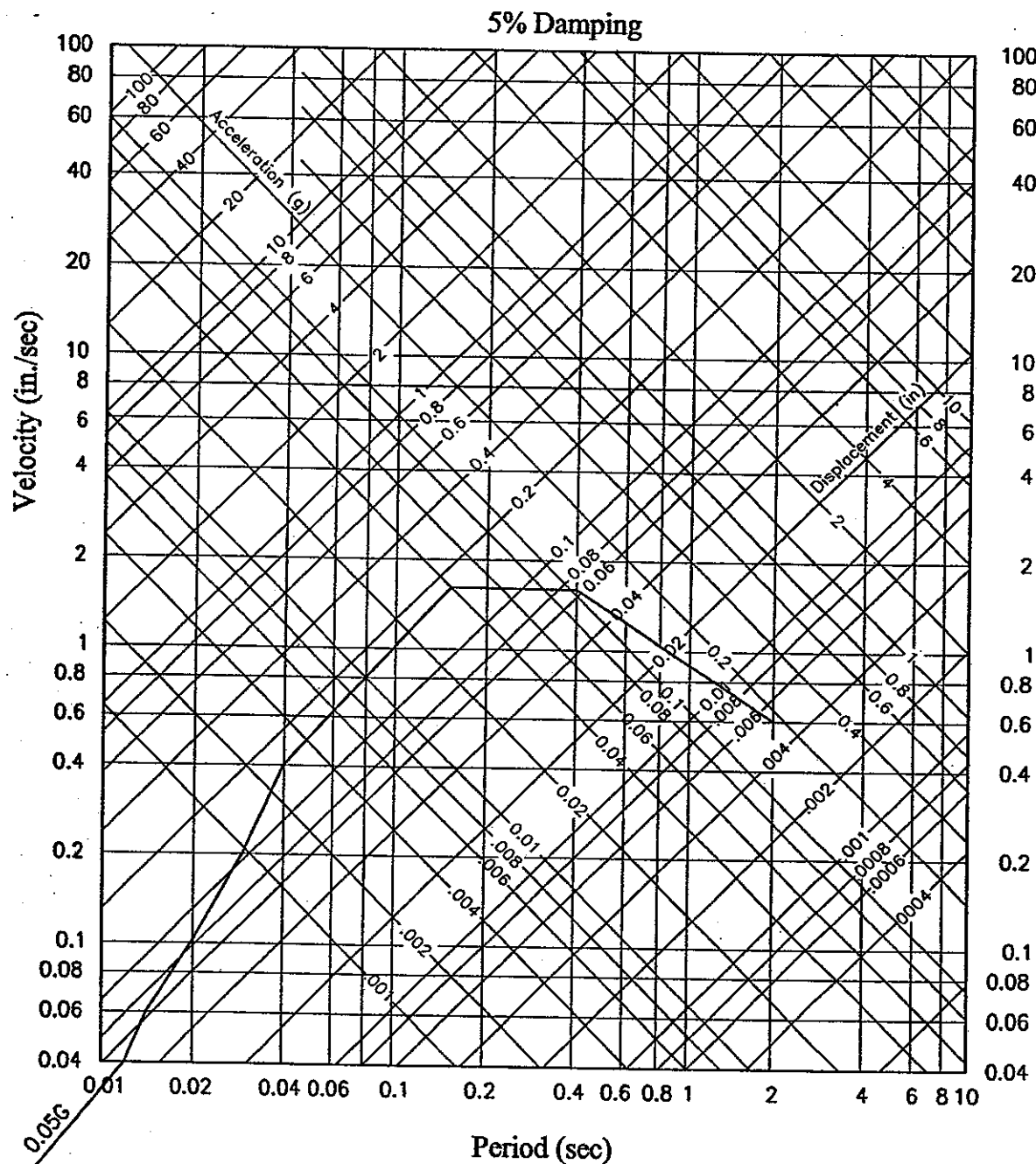


Figure 2.7-2 Evaluation basis earthquake response spectra horizontal ground motion for Portsmouth (ES/CPNE-95/2, Seismic Hazard Criteria for the Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio, U.S. Department of Energy Reservations. December 1995)

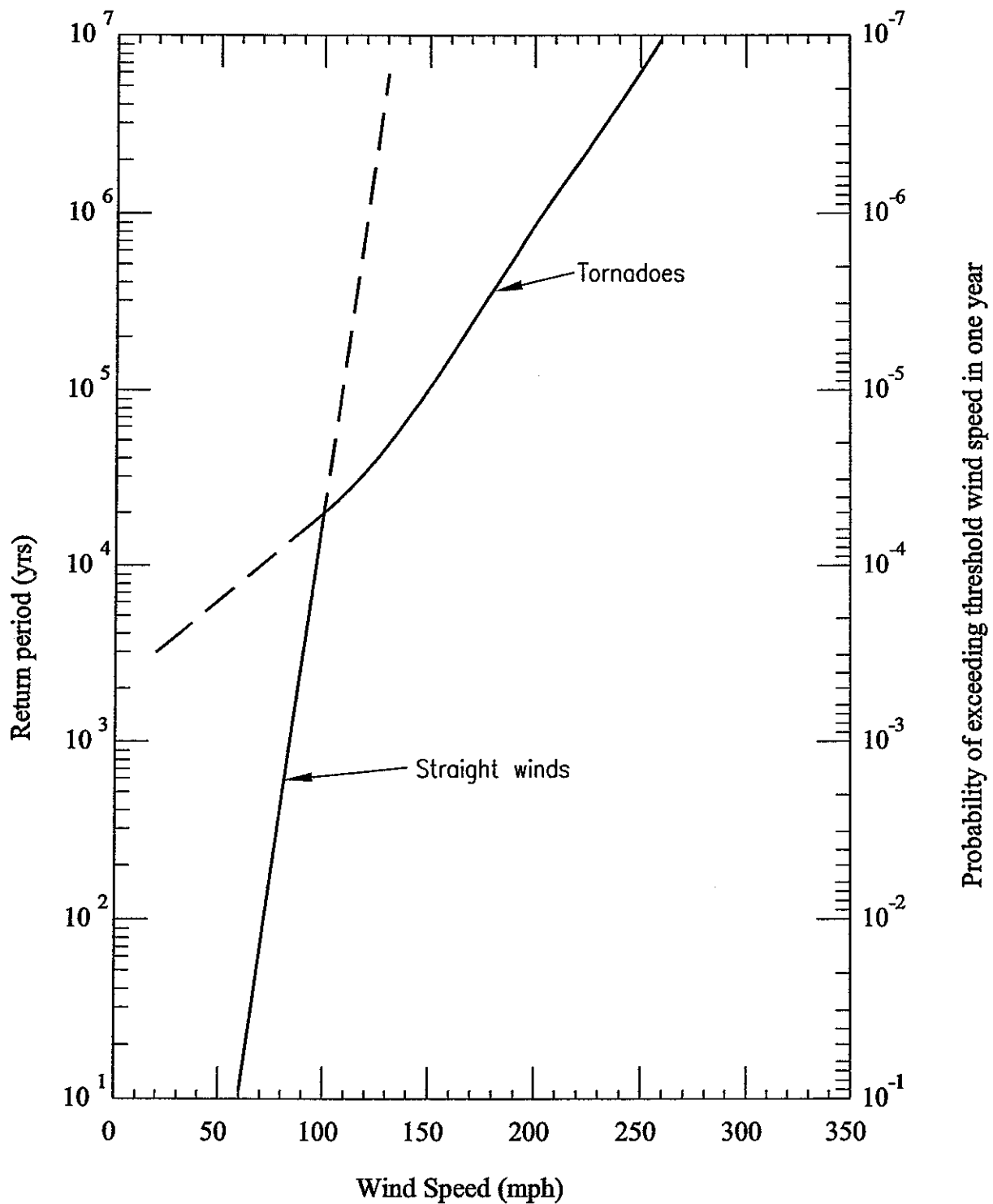


Figure 2.7-3 Wind Hazard at the Portsmouth Gaseous Diffusion Plant, Ohio.

(Source: Coats and Murray 1985)

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Note: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
Both deleted and added text require consideration in PCR 10 CFR 76.68 process

## **2.8 EXTERNAL MAN-MADE THREATS**

A number of man-made threats external to the PORTS facilities were identified for further study with regard to their potential impact on the operation of the plant. Specifically, these threats include aircraft flying nearby that could crash on the plant site, transportation accidents on nearby public highways resulting in explosions affecting the facility, transportation accidents involving barge traffic that could result in an explosion affecting the facility, the rupture of natural gas transmission pipelines located near the plant, and the release of toxins or asphyxiants that could affect plant operations personnel due to an accident.

### **2.8.1 Aircraft Crashes**

An in-depth analysis was performed to study the probability of aircraft crashes resulting in damage to the plant facilities. This analysis was based on a methodology established in the NRC Standard Review Plan (Dagenhart 1995). It is based primarily on the distance between the site under evaluation and the various sources of aircraft hazards. These sources include, but are not limited to, airports, heliports, federal airways, holding patterns, approach patterns, restricted airspaces, military training routes, and military operation areas.

This analysis shows that the largest structures evaluated (Buildings X-330 and X-326) each have an annual frequency of  $2.1 \times 10^{-7}$  per year of being struck by an aircraft. This frequency is below the risk of concern when compared with other risks associated with operation of PORTS.

### **2.8.2 Highway Accidents Near the Facility**

Traffic accidents on public highways near the plant were considered to have the potential to affect plant structures because of overpressures that could reach the site as the result of an explosion. A calculation was performed using the contents of an 18-wheel tanker truck carrying gasoline as the worst case source of an overpressure event. This calculation was performed using accepted principles of overpressure calculation set forth in *DOD Ammunition and Explosives Safety Standards*.

The results of this calculation show that the plant is located a sufficient distance from the nearest highway likely to encounter tractor-trailer traffic (i.e., U. S. Highway 23, which is nominally 1 mile away from the plant) such that explosions being initiated from an accident of this type would not affect the site.

### **2.8.3 Barge Traffic Accidents on Nearby Waterways**

Barge traffic does not flow on the Scioto River, which lies about 1 mile from the PORTS facility. The Ohio River does accommodate barge traffic; however, it is situated outside of the 5-mile evaluation zone.

### **2.8.4 Natural Gas Transmission Pipelines**

Due to the USEC decision to discontinue uranium enrichment at PORTS, it is necessary to provide an alternative heat source for DOE facilities that had been heated by the Recirculating Heating Water

Note: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs.  
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(RHW) System. The DOE alternative heating system (RHW Boiler System) consists of two hot work boilers, pumps, controls, and associated equipment in the northeast corner of the X-3002 GCEP Process Building. A natural gas pipeline is installed from the Pike National Gas Company pipeline near the East Access road and buried about four feet underground to supply fuel for the boilers. The original pipeline is installed approximately parallel to the East Access Road on its north side to the east of Perimeter Road, crosses Perimeter Road and runs parallel to the security fence on its south side until it reaches Grebe Avenue, and finally enter the northeast corner of the X-3002 building. The original pipeline is tapped just east of Grebe Avenue and a 6" line runs north approximately 600 feet, where a blanked-off tap is installed for future use. At this point the gas line is reduced from 6" to 3" and runs west (under Grebe Avenue) for approximately 200 feet, the line then runs north to the UDS Conversion Facilities. The natural gas pipeline is reduced in pressure to 100 psig when entering the PORTS site and is reduced east of X-622 to 30-40 psig.

DOE performed analyses (ASA-SM-3002-0001) for the original installation of the natural gas pipeline, the fuel oil storage, and the X-3002 RHW Boiler System operation. These analyses show that there would be no impact from accidents involving explosions or fire at the natural gas pipeline on USEC facilities containing or processing NRC regulated materials. While there could be some minor structural damage and injury to personnel, a fire or explosion would not affect the function of any USEC facilities (with the exception of the X-1107BV vehicle portal which could suffer damage and possible irreversible health consequences to personnel in the portal in the event of an explosion). These analyses were used when evaluating the installation of the additional gas line (north from just east of Grebe Avenue). The installation of the 3" gas line to the UDS Conversion facility is bound by the original analyses. Therefore, there would be no significant impact to any USEC facilities containing or processing NRC regulated materials. There would be minor structural damage and possible ear drum rupture to personnel at the X-1107DV vehicle portal in the event of an explosion. The analyses show that a fire at the fuel oil storage would not impact any USEC facilities containing or processing NRC regulated materials; a large fire could require evacuation of the USEC X-7721 facility, however, it is unlikely that the facility would be damaged.

DOE has installed emergency shutoff valves at the site boundary to stop gas flow on detection of low pressure/high flow rate condition due to a pipeline rupture (these valves also have overpressure protection). The gas pipeline route is clearly identified to minimize the potential for excavation initiated accidents. The pressure reducing valve (100 psig to 30-40 psig) with a second emergency shutoff valve is installed at least 125 feet east of the X-622 facility.

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reserve. Pumps in the X-6644, Fire Water Pump House, can feed water from the tank into the sanitary distribution headers.

The distribution system connects X-611C and X-6644 with the 250,000-gallon X-612, Elevated Water Tank (Figure 3.4-8). The water tank level is maintained by the sanitary water pumps located in X-611C. The water tank is a reservoir which "floats" on the sanitary water loop distribution system, filling when the system demand is below the X-611C sanitary water pump(s) output. The distribution system loop pressure is controlled by the sanitary water pump discharge and storage tank level/pressure relationships.

The distribution system supplies the plant site with sanitary water, and it supplies the sanitary Fire Water System.

#### **3.4.2.2.2.4 Protection Systems (Sanitary and Fire Water Facilities)**

A sprinkler system is located in X-611C for fire protection. The filterhouse is also protected by the plant fire protection and evacuation alarm system.

Two of the sanitary water pumps in X-611C are dual powered (electric motors and diesel engines). The diesel engines are used as back-ups in the event of a power failure.

#### **3.4.2.2.2.5 System Controls (Sanitary and Fire Water Facilities)**

Controls for feeding carbonic acid into the carbon basin at X-611 are located in X-611D. Controls for feeding chlorine are located in X-611E. Controls for feeding the polyphosphate are located in X-611C.

Each of the filters in X-611C is equipped with a control console which allows filter and backwash cycles to be performed. The clearwell is equipped with instrumentation to indicate water levels.

The sanitary pumps in X-611C can be started and stopped locally, at the filterhouse. The emergency diesels are set to start automatically on loss of normal voltage to the electric motor starters.

#### **3.4.2.2.3 Recirculating Cooling Water System**

The function of the RCW System is to supply cooling water to the process buildings and some auxiliary buildings. The heat of compression of the process gas (PG) is transferred through the coolant systems to the cooling water and then to the atmosphere.

In the plant RCW System, there is one subsystem for each process building—the X-626 RCW System, the X-630 RCW System, and the X-633 RCW System. Each subsystem consists of a pumphouse, cooling tower system and associated piping.

The RCW System is supplied with water from the Raw and Makeup Water System. Makeup water is fed into the RCW Systems at the pumphouses where it is chemically treated along with RCW that has been returned from the cooling towers. The chemical treatment is accomplished in the pumphouse wetwell from which the water is pumped into the process buildings header systems. A double header system consisting of two banks of pumps and two headers per system provides cooling water to the process equipment. The heated water from the process equipment cooling system is returned via the return headers, return piping and risers to the distribution headers in the cooling towers. A portion of the returned RCW is lost through evaporation when passing through the cooling towers while the remainder

accumulates in the cooling tower basins. The cooled water flows from the tower basins, back to the pumphouse well to again be treated and circulated as cooling water.

RCW instruments, at the RCW pumphouses, that monitor the temperature of the RCW supplied to the Evacuation Booster Stations in X-330 and X-333 are nuclear criticality safety components (see Section 5.2, Appendix A)—however, they are not active engineered features (see Section 3.8.10). These instruments consist of temperature indicators that are located in the RCW pump rooms.

Some of the heated water from X-630 is pumped through the RHW System prior to its return to the cooling towers. The RHW System is described in Section 3.4.2.2.4.

#### **3.4.2.2.3.1 Recirculating Cooling Water Pumphouses (X-626-1, X-630-1, X-633-1)**

The RCW pumphouses act as control centers for the three RCW subsystems. In addition to the recirculating pumps and equipment, chemical feeders, pumps, motors, valves, switchgear, and recorders are located in the pumphouses.

##### **Recirculating Cooling Water Pumps and Motors**

The X-626-1, Recirculating Water Pump House, contains six RCW pumps each powered by an electric motor. The X-630-1, Recirculating Water Pump House, contains eight pumps. Each pump is driven by an electric motor. X-633-1 contains 14 RCW pumps, which are powered by electric motors.

##### **Recirculating Cooling Water Chemical Feed Systems**

Each pumphouse is equipped with a chemical feed system. The systems include equipment for the dispensing of biocide, sulfuric acid, mild steel corrosion inhibitor, copper corrosion inhibitor, and a dispersant polymer.

A biocide is used at all three pumphouses for microbiological control.

At X-626-1, X-630-1 and X-633-1, sulfuric acid is fed directly into the pumphouse wet well from a storage tank located outside the pumphouse. The acid storage tanks at X-626-1, X-630-1, and X-633-1 are permanent units with capacities of 5,000, 10,000, and 10,000 gallons, respectively.

Chemicals for the phosphate-based corrosion control systems are fed from bulk storage tanks or portable shuttles into the pumphouse wetwell. The chemicals used are part of a phosphate-based program.

#### **3.4.2.2.3.2 Cooling Towers**

There are seven cooling towers in the RCW System: one at X-626-1, two at X-630-1, and four at X-633-1. In all of the towers, the heated air is discharged at the top of the tower and the cooled water is collected in a basin located under the tower.

RCW flows from the process heat exchange equipment into the return header, through the risers to the top of the tower, and into the tower distribution system. The water is evenly distributed in the top portion of the cells, and is cooled as it falls through the tower cells. A riser bypass line (except X-626-2 Tower) allows RCW return water to be routed directly into the cooling tower basin. To enhance cooling, a fill material is

placed in each cell. The fill is constructed so that the water falling through it breaks into small droplets, enhancing heat transfer.

#### **3.4.2.2.3.3 Recirculating Cooling Water Distribution Piping**

RCW distribution piping consists of supply and return headers, bypass and blend lines, and blowdown lines.

##### **Recirculating Cooling Water Supply and Return Headers**

Two headers from each pumphouse supply water to opposite sides of their respective process building. At X-630-1 and X-633-1, there is a crossover line between the supply headers just outside each pumphouse. At X-626-1 the supply headers are tied together inside the pumphouse. There are also two return headers from the process building to the cooling tower(s). The X-630 and X-633 headers are tied together before reaching the cooling towers, while the X-626 headers are tied together at the cooling tower. The crossover piping allows any part of the building supply line or return line to be shut down for cleaning or repairs. All outside piping is underground, except for the risers on the return line to the cooling towers and the blend lines.

##### **Recirculating Cooling Water Bypass and Blend Lines**

The function of the RCW (hot water) bypass is to help control the temperature of the RCW supplied to the process buildings. This is done by allowing a portion of the hot return water to flow directly into the mixing flume from the return headers, bypassing the cooling tower(s). The bypass is used as needed to aid in keeping the supply water at the desired temperature for process cooling.

To prevent damage to the cooling towers, the blend lines are used to mix cool water with hot return water from X-330 and X-333 to control the temperature of the return water.

##### **Recirculating Cooling Water Blowdown Lines**

The function of the blowdown lines is to provide a means of lowering the dissolved and suspended solids concentrations in the systems. The blowdown from the X-626 system is used as partial makeup for the X-630 system. The blowdown from the X-6000 system is used as a partial makeup for the X-626 system. Likewise, blowdown from the X-630 system is used as partial makeup for the X-633 system. A blowdown line runs from the X-633 supply header to the Scioto River. Blowdown may be routed to bypass the X-633 before it is discharged to the Scioto River.

#### **3.4.2.2.3.4 Protection Systems (Recirculating Cooling Water Facilities)**

Due to the large quantity of water flowing through the RCW Systems, the equipment must be protected from pressure changes which result from the starting or stopping of a pump or the sudden closing of a valve. Surge protection is provided by surge relief valves or cone valves, which will open and allow water to return to the wetwell if high pressure occurs in the system. Check valves or cone valves on the pump discharge lines protect from backflow through the pumps.

The cooling tower fans are equipped with vibration switches, which will shut down the fan if excessive vibration occurs.

Fire protection in the RCW pumphouses is provided by Sanitary and Fire Water System sprinklers and fire hydrants. The fire

protection for the RCW cooling towers is provided by HPFW System sprinklers. All three RCW pumphouses are protected by the plant fire protection and evacuation alarm system.

#### **3.4.2.2.3.5 Control Systems (Recirculating Cooling Water Facilities)**

RCW pumps in the RCW Systems (X-626, X-630, and X-633) can be started and stopped locally or remotely. Local controls are positioned on control panels in each respective pumphouse. Remote controls are located in X-300.

Similarly, the RCW cooling tower fans in the X-626, X-630, and X-633 RCW Systems can be started or stopped locally or remotely. Local controls are mounted on the cooling towers next to each cooling tower cell. Remote controls are located on the control panels in each respective pumphouse.

#### **3.4.2.2.4 Recirculating Heating Water System**

The RHW System consists of the necessary piping and equipment to circulate hot RCW return water from X-330 to the X-700, Converter Shop & Cleaning Building, X-705, the X-720, Maintenance & Stores Building, the X-623, North Groundwater Treatment Building, and the Gas Centrifuge Enrichment Plant (GCEP). The system provides a source of building heat. The RHW system is currently in a shutdown condition; the buildings listed above are heated by other means when the RHW system is shutdown.

The primary pumping station in X-330 is equipped with pumps, filters, flow controls and piping. RCW return water is taken from one or more of four return headers and is pumped into the distribution piping to flow to the various building heating systems. Each building serviced by the system has a pumping system to circulate water through the building heat exchange units and into the RHW return line.

### **3.4.3 Plant Nitrogen System**

#### **3.4.3.1 System Description**

The Plant Nitrogen System consists of a nitrogen plant, nitrogen storage facilities, vaporization facilities and a distribution system. The system is designed to generate and distribute nitrogen gas used in the cascade for seal feed, buffer systems, and servicing equipment when dry gas is required. Nitrogen gas is also distributed to various process auxiliary buildings. The principal nitrogen production and storage equipment is located in X-330 and just south of X-330.

The nitrogen plant consists primarily of a separation column in which the nitrogen is produced. From the separation column, the nitrogen can be routed as a gas to a distribution header or a bank of storage cylinders. It can also be supplied as a liquid to a low-pressure liquid nitrogen storage tank. The tank is normally filled from a truck. Additional liquid nitrogen storage capacity is provided by a high-pressure storage tank that is filled from a tank truck.

When needed, liquid nitrogen from the low pressure storage tank or the high pressure storage tank may be transferred to a cold converter and vaporizing unit where it is converted to gaseous nitrogen. Gas from the cylinder storage bank can be transferred to the distribution header as a supplementary source of nitrogen.